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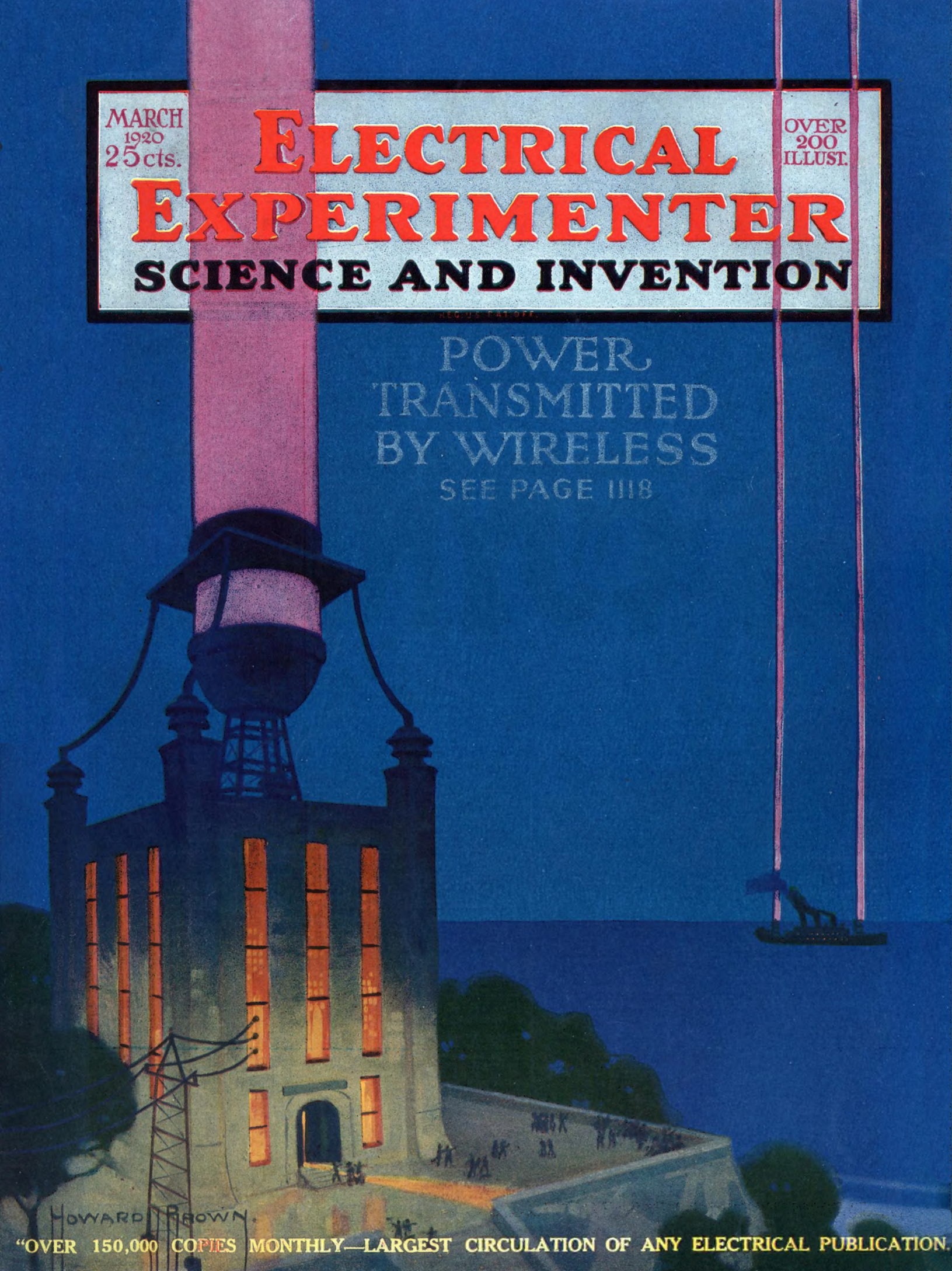

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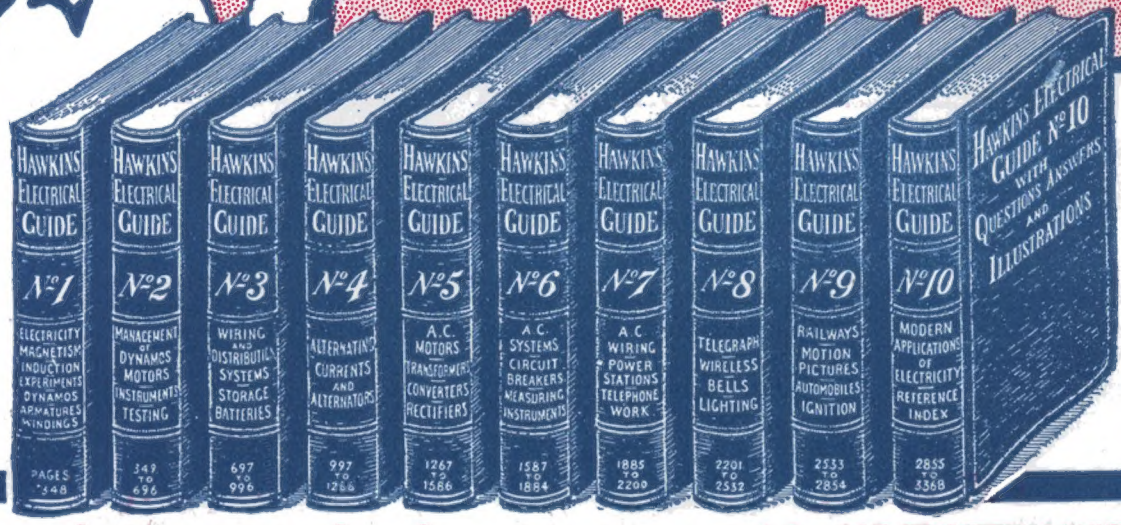

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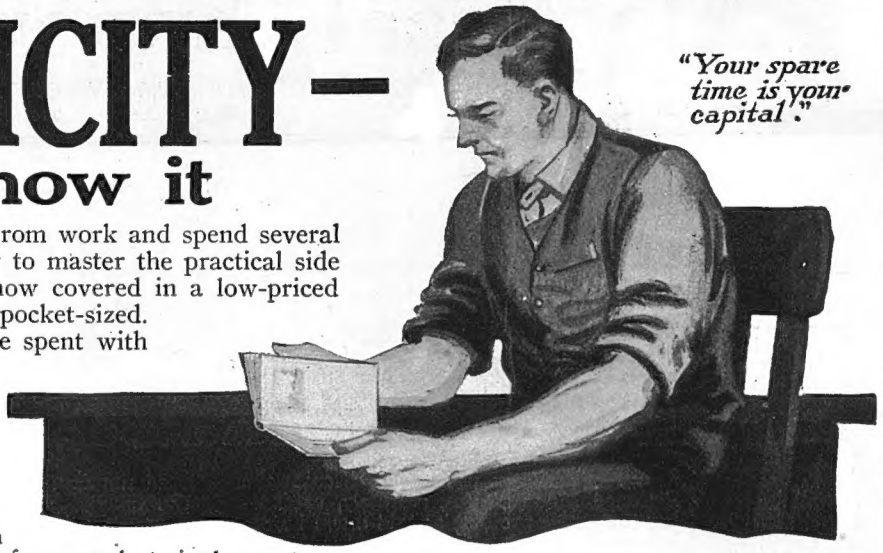

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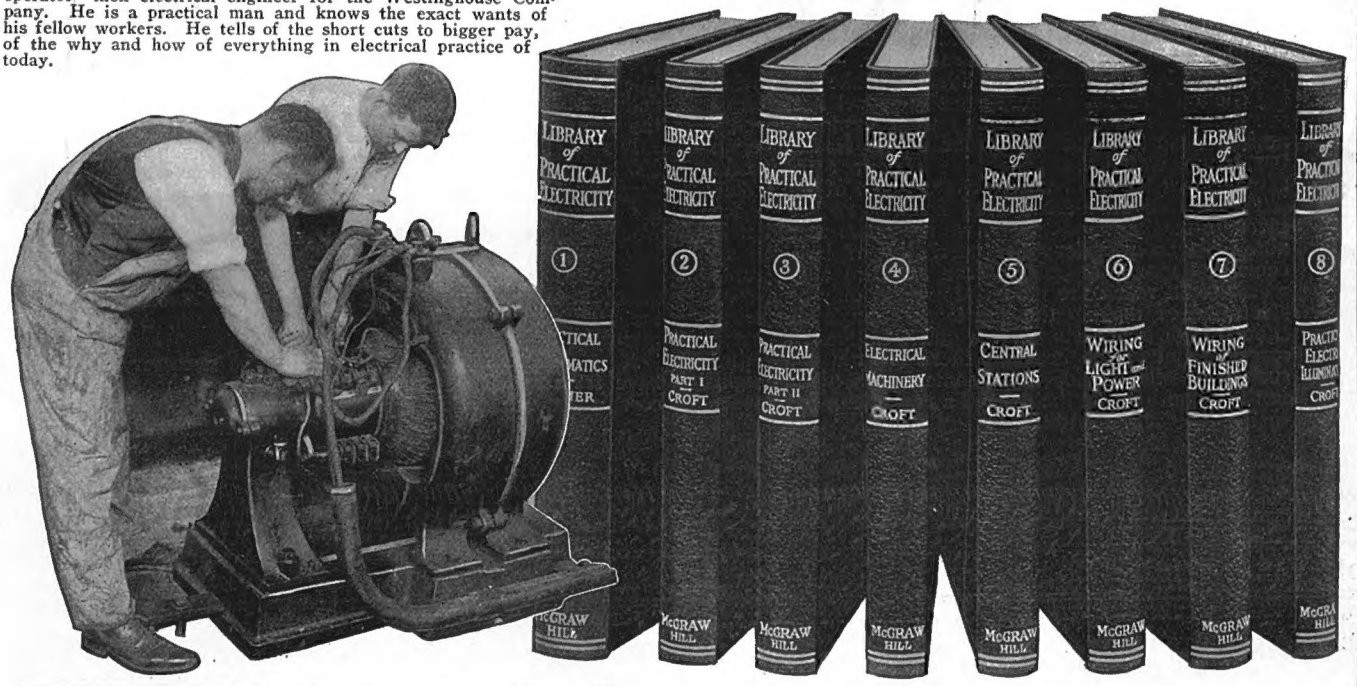

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EDITORIAL

The Moon Rocket

IN our February issue we discust the Goddard Moon Rocket minutely, presenting the entire problem as laid down by the inventor. Right here it should again be pointed out, as already mentioned in the original account, that Dr. Goddard *did not* primarily invent his rocket to travel from the earth to the moon. This was only a secondary consideration.

Once a rocket has gone up for 400 or 500 miles into the atmosphere, it would be impossible to prove by any means that it had actually reached this great heighth. A minute's reflection will show that no barograph or other recording instrument would be of any value because at this heighth there is no air.

While we know that the temperature in free space is —459° Fahrenheit, we could of course employ some sort of a recording instrument which would show that the rocket had actually past into free space. This could be verified if the temperature recorded was —459°. However, the trouble is that the rocket could go on for a thousand miles higher and still the temperature would remain just exactly the same, viz. —459°.

Dr. Goddard conceived the idea to make the rocket big enough so that it would actually propel itself on to the dark side of the moon and there explode a magnesium flash charge; the proof of its landing upon the moon would be conclusive if our astronomers actually saw the flash upon the dark side of the moon.

Theoretically the scheme of firing a rocket to the moon is feasible; practically, we are much afraid it is not. We do not deny the possibility of building an enormous gun *à la* Jules Verne and fire a projectile which could reach the moon. It would only be a consideration of making the gun large enough and using enough high explosive. If the gun were trained at the correct point in the heavens, there is little doubt that such a missile would, after some hours flight, alight on the moon. But in the case of a rocket this becomes a vastly different problem.

In the first place, it should be borne in mind that at the time when a rocket or even a shell is fired, it is of course not fired at the moon at all. The reason is that it takes many hours or even days for the projectile to land upon our satellite. For that reason when we fire the gun or the rocket, it becomes evident that it is fired direct into space with no moon anywhere in sight. In other words, the gun is trained on a certain point in space, accurately calculated by astronomers, the calculation being such that we will know the length of time it will take the projectile to traverse the space between the earth and the moon. The latter during this period will have moved to the point where it will intercept the flight of the projectile. As to the Goddard Rocket, it has been calculated that it would take about 100 hours to traverse this space of 220,000 miles.

Granted that we had fired the Rocket on a very calm day when there was no breath of air stirring, so as not to deviate the path of the rocket even an inch (and this condition alone is almost impossible), we now come to the next consideration. A rocket which propels itself in a vacuum will not move in an absolute straight line. The reason is that the explosions acting upon the body of the rocket will not project the rocket *exactly along its axis.*

It should be remembered that it has to traverse 220,000 miles to hit an object 2,164 miles in diameter. Consequently, it can be readily seen that a deflection of a small fraction of an inch to either side at the start would prevent the rocket from making a successful landing upon the moon.

Even if meteorites never actually hit the rocket, many, however, would certainly come near enough to the rocket to draw it slightly out of its path, due to gravitational attraction.

If a rocket is ever used, it would be necessary to have it carry with it some human beings, who could correct these influences along the way.

H. GERNSBACK.

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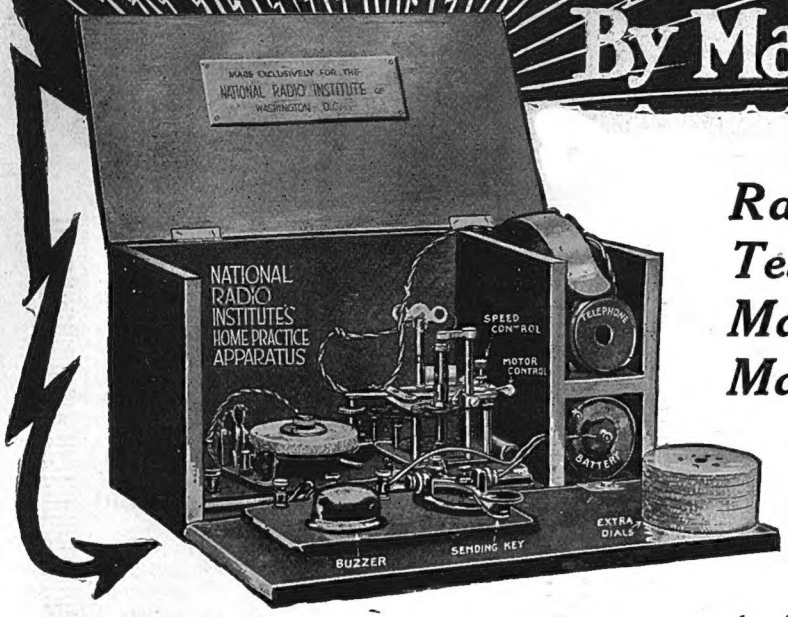

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How I Improved My Memory in a Half Hour

And Performed A Remarkable Memory Feat That Same Evening

The True Experience of RALPH GORDON, Cartoonist and Writer

THIS is my story. Out of the ordinary? Amazing? Emphatically so—but absolutely true.

I put off sending for the Roth Memory Course until I could not resist the temptation any longer. My deep conviction after reading the publishers' announcements told me that here was something I could not afford to miss. And how *literally* true that was you will understand when I tell you this almost unbelievable, but to me perfectly simple and natural, personal experience.

On October 16, 1919, I brought home with me the Roth Memory Course. I still pinch myself to see if all the wonderful results obtained that first evening are really true.

I had always been discouraged at my poor memory. In some respects it was remarkably good and stood me in good stead in my business of cartooning; but in many other respects it was shockingly feeble—and caused me constant embarrassment, self-reproach, and vexation.

Well, this is what happened—when I made the glorious discovery that set me right.

On that memorable evening I had an engagement at a Masonic banquet of the Doric Lodge in Toronto, where I was scheduled to do one of my cartoon sketching acts.

My appearance at the banquet was scheduled for 10 o'clock. I also had to meet a man at 8 o'clock, from which appointment I return home at 8:30.

With a half-hour to spare, I opened my Roth Memory Course just received that day. And, presto! I was deep in it—from the first crisp introduction to the absorbing pages that followed.

I read only 24 pages. Please mark, I *read* them only—didn't give them any study—for there was no time for that.

But in this quick reading, I fixed in my mind Mr. Roth's first 50 code words, and 20 words of my own selection without the slightest mental effort. It was impossible to "stick" me. I could repeat them any way I was asked.

Then I went to the banquet. While I was awaiting my turn on the program, I conceived the wild idea of putting on a memory demonstration after my cartooning act. It scared me, but I went through with it.

I asked one of the guests to call off 20 words, which I immediately repeated forward and backward without a mistake.

A second list of 20 words I handled just as easily, making in all 110 words I had memorized.

Mind you, all this with only a half-hour's reading of Mr. Roth's course—and no chance for study!

After the banquet I gave the list again, without a single error except the careless transposition of two words—not a mistake of memory.

It was 12:30 o'clock before my amazed and fascinated friends would let me go.

I went to the home of one of the officers of the Lodge the following evening and continued the test still further. The next surprise came when, upon arriving at my friend's home, I wrote down, without a moment's hesitation, all the words that had been given me at the banquet, and called them off in precisely the order given.

He was astounded, but I was more than that, for I realized that suddenly and almost miraculously I had discovered the secret of an infallible memory. Its possibilities loomed up to me then in enormous proportions.

I would not have believed this experience if it had not happened to me—myself. I would have doubted the truthfulness of even my most trusted friend, had he claimed to do what I did so easily and simply on that momentous evening of the banquet.

Lest you doubt me, I will quote here two letters from those who can vouch for my sudden acquisition of an improved memory.

Harry R. Reid, Worshipful Master, Doric Lodge Number 316, Toronto, Canada, affirms in part:

> "This certifies that Ralph Gordon appeared on the program last evening at our lodge banquet. After the banquet he gave a memory test before the officers present in which we gave him 20 words that he did not know.
> Then, after looking at the list for a few minutes, he turned his back to the easel and repeated the list forward and backward, making only one mistake, which was a slip of the tongue and not of memory. This is the more remarkable because he had given the subject only a half hour's reading before coming to the banquet—A wonderful feat!"

J. A. Montgomery, Vy. W. Past Master of the same Lodge also affirms:

> "I was present when Mr. Gordon gave a memory test. Next evening he called upon me, asking to continue the test. He asked me to take a pencil and paper, and write down a list of words. 'Now,' said Mr. Gordon, 'I shall repeat for you, backward and forward, the words you have called off.' This he did without a mistake. I was simply astonished. I consider this test an extraordinary exhibition!"

Just one more amazing result of my reading of Mr. Roth's course, and I leave the idea to you for what it is worth (which I claim is a great deal), with the earnest advice that you do not waste a single instant in getting this wonderful secret from the "Master of Memory Masters."

The following poem, just as given here, I wrote down from memory immediately after reading Lesson 4 of Mr. Roth's course as far as this poem. I read it only twice. Think of it! You will not believe this until you have secured Mr. Roth's course—then you will.

These are the things I hold divine;
A trusting child's hand laid in mine,
Rich red earth and wind tossed trees,
The taste of grapes and the hum of bees,
A rhythmic gallop, and bright June days,
A rose-hedged lane and lovers' lays,
The welcome smile on neighbors' faces,
Cool, wild heights, and open places,
Breeze-tossed fields of silver rye,
The wild, sweet note of the plover's cry,
Summer showers, the scent of lox,
The soft pale tint of the garden phlox,
Blooming lilacs, a lazy noon,
The flight of geese and an autumn moon,
Rolling meadows and storm-washed heights,
A fountain's murmur on summer nights,
A dappled fawn in the forest hush,
Simple words and the song of the thrush,
Rose red dawns and a mate to share
With comrade soul my gypsy fare,
A waiting fire when the twilight ends,
A gallant heart and the voice of friends.

My only mistakes were "summer showers" for "fresh spring flowers", "breeze tossed" for "breeze blown", the article "the" for "a" in a few places, and one or two other slips that did not change the meaning or rhythm of the original.

Mr. Roth's publisher tells me that a half million people already are using Mr. Roth's memory system. I am not surprised, as you may imagine from the foregoing. There is not a man or woman in this United States who cannot get every real benefit, and astonishing results in memory improvement, from Mr. Roth's wonderful and fascinating course.

Don't fail to look into it.

RALPH GORDON.

November 4, 1919 Toronto, Ontario

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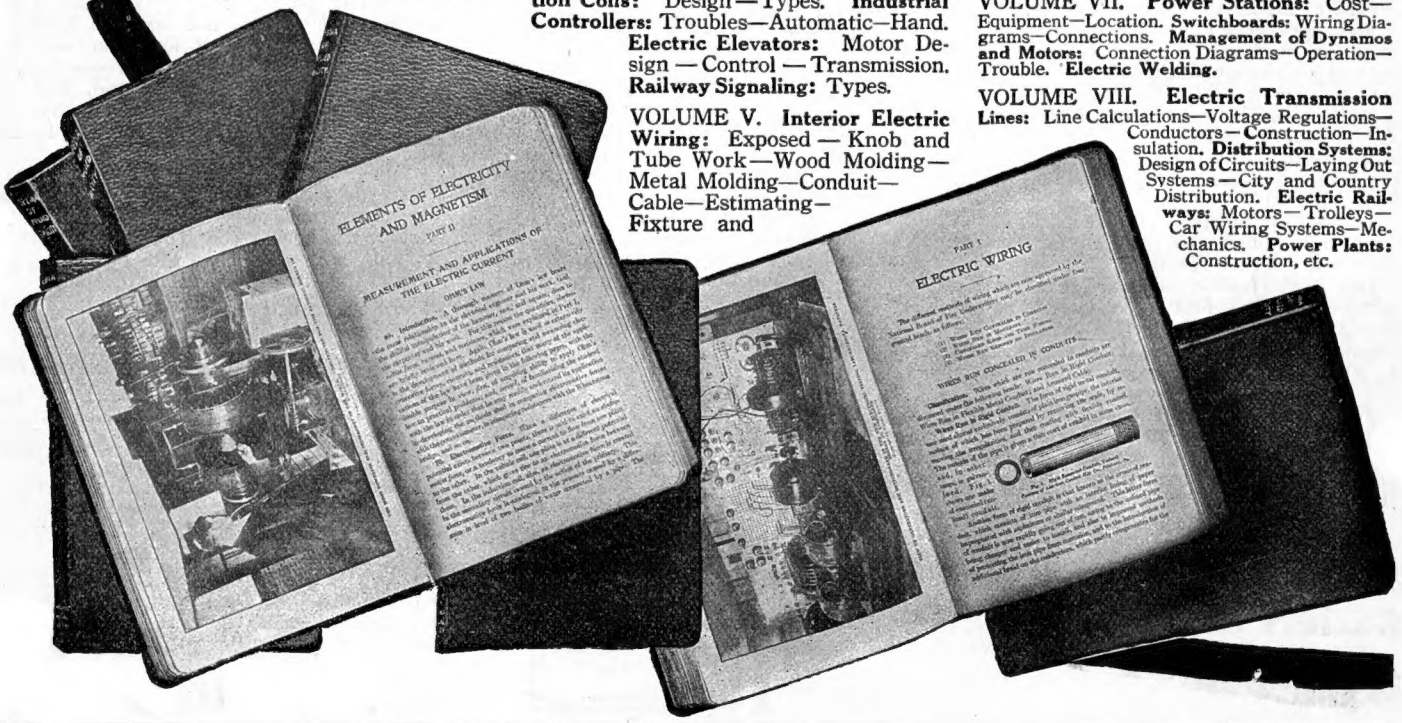

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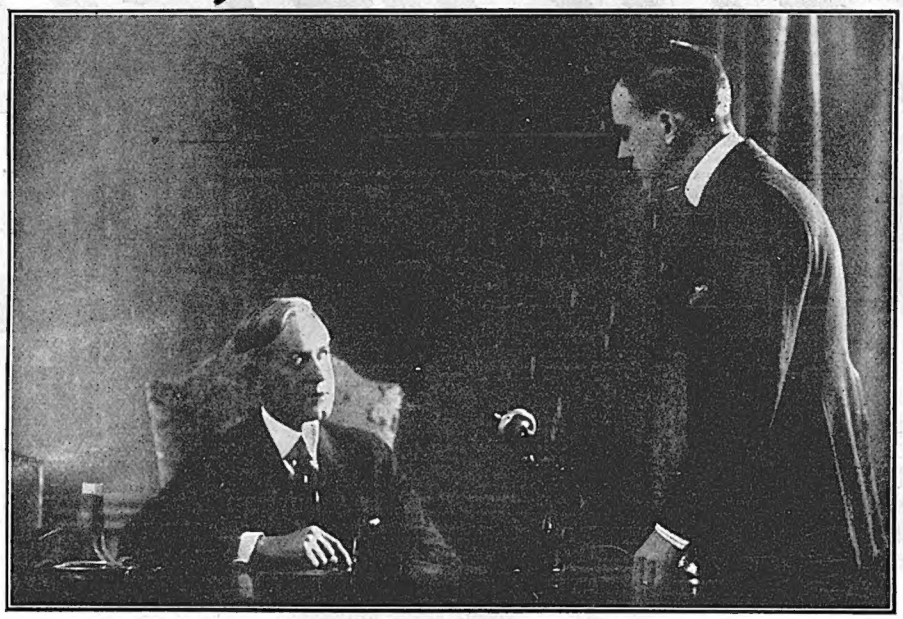

"Collins . . . . . the office is the place for you, you are no salesman."

By Preston Collins

"PERHAPS you do not altogether like the proposition my firm has offered you?" I asked weakly of Mr. Farrelly, the General Manager of the Warren Stone Company—for whom I had prepared what seemed to me a wonderfully convincing selling talk. He took me at my word. He *agreed* with me, and snapped back:

"No, I do not!" My prospect turned abruptly aside to other matters, as I stood there fumbling my hat, and wondering what under Heaven I could say next, if anything.

I was beaten, completely. Mr. Farrelly was preparing to answer his mail. He had forgotten me completely. The incident was closed.

My second month as salesman for the Driscoll Casting Company, and another failure chalked up to my discredit!

The reason should have been as plain as day to me—yet I was just blind enough not to see it at all. But when I went back to our Sales Manager, I got enough food for thought to last me a long time. Said he, quite frankly:

"Collins, the office is the place for you. You are no salesman. You just don't know how to talk. For one thing you are too timid. You have no confidence in yourself."

"Imagine suggesting to Mr. Farrelly that there was the slightest chance of his not jumping at your proposition. Yet that is just what you did."

"NOW let me tell you something about selling goods. I won't tell you where I learned it till later."

"In the first place, do you realize that it is *instinct* that makes a man accept your offer as well as careful reasoning. If he thinks you expect him to buy —that you look upon this as a foregone conclusion, he is far more likely to sign on the dotted line. If he has the least suspicion that you doubt your ability to make the sale—especially if anything you say gives him that impression—you might just as well say goodbye right then to the order you have dreamed so fondly of taking away with you."

"The word of command is all important. It is absolutely essential, and the one thing above all others that brings home the bacon. When the trolley conductor announces 'all out, take the car ahead' everybody gets out and nobody asks why. They just do it. So, when you say 'Sign here' Mr. Prospect is more than likely to do as you say without further discussion, provided of course you have made it clear to him that your goods are what he can use."

"But these are only a few small points in the One Great Fact of Salesmanship which gave *me* the secret of making people buy what I wanted to sell them."

"HAVING plugged along for years with only indifferent success as a salesman, I suddenly ran into a big idea which I assure you has meant more to me in my selling career than all the other business things I ever learned put together."

And with that the Sales Manager pulled out a set of well-thumbed pamphlets, which I saw bore the title "The Newcomb Course in Super Salesmanship."

"If you will study these a few

evenings," said Mr. Beardsley, "you will make me take back what I said about your being a poor salesman—unless you have got different stuff in you from what I have been led to believe."

"Here you will find Arthur Newcomb's secrets of selling, which he has formulated as a successful salesman, and as a man who has taught thousands how to be masters of this paramount acquirement in business."

BEARDSLEY lent me that course then and there, and I hesitate to tell you what the result was, because it was so unbelievable.

Those seven lessons were a revelation to me. I'll say they were! It took me less than one hour to discover in them things that upset completely my earlier notions of salesmanship.

I had thought the title of the course pretty ambitious—"Super Salesmanship." It is a pretty big word, but absolutely right if my experience is any criterion. Judge for yourself by what I was enabled to do.

I studied the Newcomb course, and I studied it hard. Then I started out again and never lost a chance to apply what I got out of the lessons.

I had soon found out that all salesmen can be classified into three types: First, and in the large majority, are the incompetents. They generally go away empty-handed. Occasionally, one of them gets a little order. But all men of this type ever get from coldly efficient buyers is a quick application of high-bred freezing process. They have nothing but contempt for inefficiency.

The second class consists of the medium-grade salesman. These men are turned down, however, oftener than they get orders.

Out of all salesmen there are only a small percentage who nearly always make a sale. They seldom go away empty-handed. Nor do they talk much, nor work at all hard to make a sale. They make up the third class—the Master Salesmen.

How do they do it? From the lessons I found that consciously or unconsciously they use the One Great Rule of Successful Selling. Even though these men express themselves differently and are entirely different types of men, they all use The One Great Rule. And the men who fail to sell do not use this rule.

Then came the interest in the course that no novel can give. With the swiftness of lightning

"Right from the start I sold goods in substantial quantities"

I was well nigh paralyzed with Revelation. I possessed the one, the all-embracing Rule that would make me, failure at selling that I was, a super-salesman.

Though I may have a thousand future lives to live, I believe that I can never forget those wonderful moments when I first read of The One Great Rule of Successful Selling and Its Hundred Devices. It was mighty knowledge to have and use.

To make my story short, I soon proved to Mr. Beardsley that it would pay him to put me on the road.

Right from the start I sold goods in substantial quantities. In nine short weeks my sales topped the list of our entire selling force. You can well imagine my joy. I had actually out-distanced "Old Timers" and had become the firm's Super-Salesman.

On my return from my first trip, I remember that Mr. Beardsley called me into his office, gave me a cigar, and said cordially, with his hand on my shoulder:

"Collins, you've made me eat my words. I told you once you were a selling-failure. I'll take it back. As a salesman you're certainly all there."

Today I am holding down the job Mr. Beardsley did when he gave me that talk about the Newcomb course. He is now Vice-President of our company. But for what I have done I claim no special ability. I had only a grade school education, and never was considered anything out of the ordinary intellectually. I say this frankly, as I have no desire to pin roses on myself.

The point I want to make is this: If I, with these handicaps, could so quickly become a top-notch salesman, it is only reasonable to suppose that others can, too. The thing that so quickly made me a Master Salesman was a knowledge of The One Great Rule in Selling and Its Hundred Devices, told by Arthur Newcomb in his astounding 7-Lesson Course in Super-Salesmanship.

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You need not take anyone else's word for what the One Great Rule of Selling will do for you. You can be the judge yourself. Send no money. Mail the coupon. This will bring the complete Course to you on five days' approval. Examine it thoroughly; test it out in actual experience. Then if you feel that you can get along without it, send it back and you will owe nothing. But if you want to make it yours, as you surely will, remit only seven dollars in full payment.

As this special free trial offer may be withdrawn at any time, it is suggested that you take prompt action and mail the coupon now.

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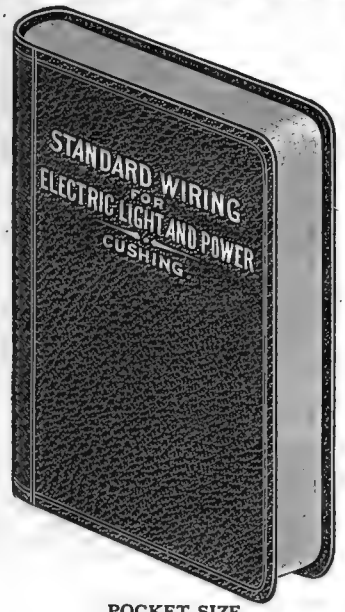

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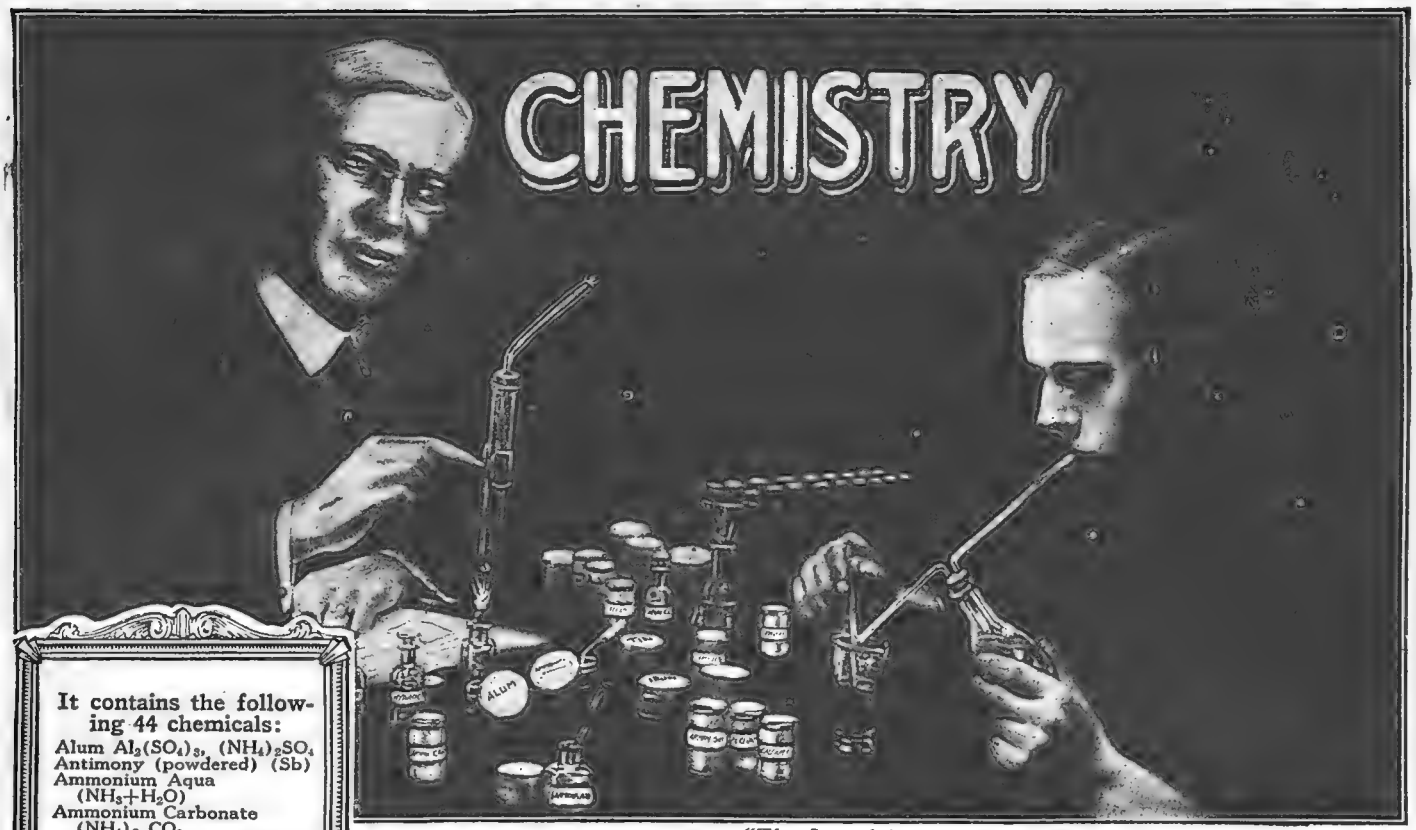

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DESCRIPTION OF THE OUTFIT:

The outfit consists of forty-four (44) Chemicals all C. P. (chemical pure) put up in appropriate wooden boxes, glass bottles, and hermetically closed jars. The acids are put up in glass bottles, with ground-in glass stoppers and there is a sufficient quantity of chemicals supplied (mostly one to two ounces) enough to make dozens of experiments with each. See list of Chemicals herewith.

The apparata furnished are all of the best obtainable make and of standard laboratory size and shape. A list of the 17 pieces of apparata furnished with this outfit is printed also herewith.

The Instruction book is a real **Chemistry Course for the Beginner.** Some of the Contents are: **Division of Matter:** This is a Treatise on Elementary Chemistry and deals with the theory of the Elements, Molecules and Atoms, etc. **Chemical Nomenclature:** This explains in simple language the derivation of the chemical names of the Elements and their compounds. There is a chapter on **Laboratory Operations; Glass Working; First Aid; Fire Extinguishers; Experimenters' Aphorisms,** etc.

A good part of the book is devoted to Weights and Measures. The Metric System, the English system and the U. S. System are fully explained.

The following tables are furnished: Symbols and Atomic weights of the Elements; Measures of Weights, Volume, Capacity and Length; Per Cent solutions; Conversion of Measure expressed in parts; Poisons and their antidotes; Technical and common name of chemical substances; Formulas for Cleaning various substances, etc., etc.

Among the **100 Experiments** are:

How to make chemical tricks; How to make invisible and magic inks; How to test flour; How to test soil; How to Make Chlorine Gas and smoke (German War Gas); How to bleach cloth and flowers. How to produce Oxygen and Hydrogen; How to make chemical colors; How to test Acids and Alkalies and hundreds of interesting hints and formulas.

It contains the following 44 chemicals:

Alum $Al_2(SO_4)_3$, $(NH_4)_2SO_4$
Antimony (powdered) (Sb)
Ammonium Aqua (NH_3+H_2O)
Ammonium Carbonate $(NH_4)_2CO_3$
Ammonium Chloride (NH_4Cl)
Ammonium Sulphate $(NH_4)_2SO_4$
Barium Chloride $(BaCl_2)$
Boric Acid (H_3BO_3)
Brimstone (Sulphur) (S)
Calcium Chloride $(CaCl_2)$
Calcium Oxide (CaO)
Calcium Sulphate $(CaSO_4 2H_2O)$
Charcoal (Carbon) (C)
Chloride of Zinc $(ZnCl_2)$
Copper Sulphate $(CuSO_4)$
Ferrous Sulphate $(FeSO_4)$
Ferrous Sulphide (FeS)
Glycerol (Glycerine) $C_3H_5(OH)_3$
Hydrochloric Acid (HCl)
Iodine (I)
Iron Chloride $(FeCl_2)$
Iron Oxide (Fe_2O_3)
Lead Acetate Pb $(C_2H_3O_2)_2$
Litmus Paper
Magnesium Carbonate $(MgCO_3)$
Manganese Dioxide (MnO_2)
Mercury (Quicksilver) (Hg)
Nickel Chloride $(NiCl_2)$
Oxalic Acid $(H_2C_2O_4)$
Sodium Bicarbonate $(NaHCO_3)$
Sodium Borate $(NaBO_2)$
Sodium Carbonate (Na_2CO_3)
Sodium Chloride (NaCl)
Sodium Nitrate $(NaNO_3)$
Sodium Phosphate (Na_2HPO_4)
Sodium Sulphate (Na_2SO_4)
Sodium Sulphite (Na_2SO_3)
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How to Get Anything You Want By Talking Convincingly

by Roger Matthews

I NEVER felt so elated in my life. Mr. Hughes had granted me an interview, and had promised to tell me his secret of success. That meant something, coming from this giant in the great world of finance.

I will admit that I half expected to hear the same old story about "honesty, hard work and sticking to the big job." But I was elated just the same, and eager to hear how the boy with no college education had risen so swiftly and steadily to the millionaire class.

You may imagine my surprise when Mr. Hughes said, "My success is due to One Thing. I mastered the art of talking convincingly.

"All success in the great world of business, in the last analysis, is getting other people to think as you want them to think—in getting the conscious, willing and hearty co-operation, the loyal support, enthusiasm and esteem of the men you meet in business."

"You must see," continued the financier, "that there is only one way to bring that about, namely to be able to talk convincingly.

"Mastery of words—that is the thing! How can you expect to get ahead if you lack the power to say what you want to say, convincingly and effectively at the instant you want to say it?"

"You may have wonderful ability, great mental power and keen instinct for business; but if you cannot put your ideas into clean-cut, convincing words, you will never realize fully your greatest ambitions."

I knew he was right. And his words thrilled me with a new courage and ambition.

This interview with the man who had talked himself to the top was the beginning of great things for me. And the best of it is that he told me how to learn the secret and make it my own.

He told me about a wonderful new method of learning the principles of convincing speech.

When I returned home, I sent for the method Mr. Hughes told me about. I began to apply the method to my daily work, and soon I was able to wield some of the same remarkable power over men that Mr. Hughes had.

When you have acquired the knack of talking convincingly, it's easy to get people to do anything you want them to do.

This knack of talking convincingly will do wonders for any man or woman. Most people are afraid to express their thoughts; they know the humiliation of being ignored with casual nod or a "yes" or "no". But when you can talk convincingly, it's different. People listen and listen eagerly. You can get people to do almost anything you want them to do, and they think they are doing it of their own free will.

In committee meetings, or in a crowd of any sort you can rivet the attention of all when you talk. You can force them to accept your ideas.

Talk convincingly and no man—no matter who he is—will ever treat you with cold, unresponsive indifference. Instead you'll instantly get under his skin, make his heart glow and set fire to his enthusiasms. Talk convincingly and any man—even a stranger—will literally take the shirt off his back to please you.

You can get anything you want if you know how to talk convincingly. You've noticed that in business ability alone won't get you much. Many a man of real ability, who cannot express himself well, is often outdistanced by a man of mediocre ability who knows how to talk convincingly.

Now, I can say, as Mr. Hughes did, in that memorable interview that started me toward success, that I too have become a convincing talker, and while I have by no means reached the position of my millionaire adviser, I have made the most astonishing strides in business, as a result of my new-found acquirement. I can make others see my point of view as I never dared to hope before.

In short, I am getting ahead so fast, that it sometimes makes my head swim. My last promotion, to General Manager, carries me to the $10,000 mark.

It seems, as I look back to my old stuttering stumbling way of speech, as if I must be someone else instead of the same Roger Matthews.

I remember how scared I used to be whenever I had to talk to the chief. I remember how confused I used to be every time I met new people.

Now it is all so different that I hardly recognize myself. My success seems miraculous, even to me, but it was really very simple.

All I did was to secure a wonderful course of seven lessons called "Mastery of Speech". This was the method that Mr. Hughes advised me to send for. The course was written by a man named Frederick Houk Law, a good speaker himself and an authority on speech, but best of all, a man who knows how to make *others* convincing speakers.

Now I never stand fumbling with my hat and my words when I call on a man. It is just second nature for me now to choose the exact words for anything I want to say; to adopt instantly the most effective way of saying it; to make a good impression on my hearers.

But I understand that I am just one among thousands who have risen to greater success through the use of Dr. Law's wonderful course.

There was Mr. Ralph L. Leonard of 89 Bridge Street, Beverly, Massachusetts. I can sympathize with him; my knees used to knock together every time I had to speak to *my* boss. Mr. Leonard says, ". . . . The very day after examining Mastery of Speech I had the confidence to go up and ask my superintendent for a transfer on the planers . . . . And, to my surprise, he gave it to me. I had for months been wanting that change, but didn't have the confidence until your Course pointed out the easy way to talk to your 'Superior.' That is only one incident where your Course was of value."

Again and again I could have truthfully repeated on Saturday night the statement that Mr. H. R. Blackman, of 26 Stevens Street, Danbury, Connecticut, makes in the first sentence following: "I have just completed the busiest and most successful week in my business career, due to a very large extent to the help I have received from reading the invaluable little books. I consider this course the best investment I ever made."

Many more experiences of those who have found the "Mastery of Speech" lessons to be strong rungs in their ladders of success have come to my attention. I am naturally an enthusiastic missionary for Dr. Law's course myself and some of my best friends have duplicated my rapid climb in business by taking my advice to send for this remarkable course.

I advise you earnestly to send for "Mastery of Speech". You have nothing to lose—for the publishers will send you the entire course on five days' free trial. Just mail the coupon as I did, and see what a wonderful experience is in store for you.

Act now, and you will thank me some day not very far distant for doing you a great favor.

You needn't send any money—not a cent. Merely mail the coupon, or write a letter, and the complete Course, "Mastery of Speech," will be sent you by return mail, all charges prepaid. If you are not entirely satisfied with it, send it back any time within five days after you receive it and you will owe nothing.

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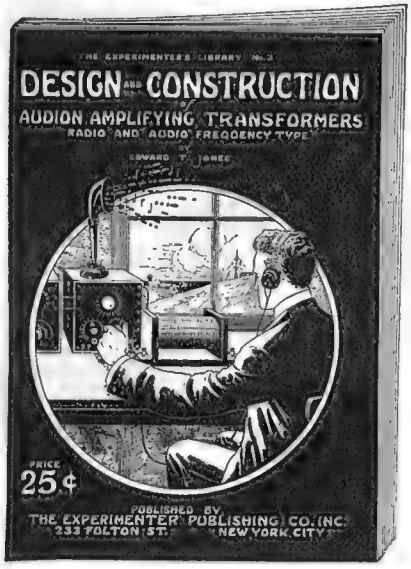

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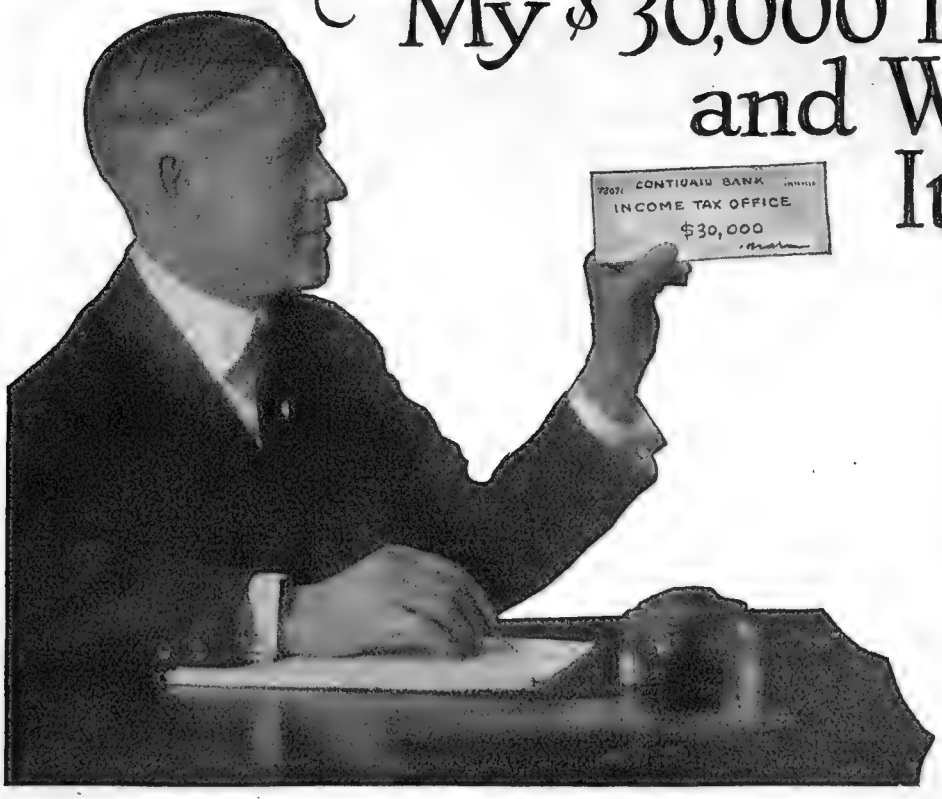
"My $30,000 Income Tax and What Made It Possible"



by Vernon Howe

Mr. Howe is one of the most successful men of his age in Forth Worth, Texas, and from all I can learn of him, few others in that city are better liked by their business associates and friends in general. Mr. Howe attributes his success and his surprisingly big income largely to his recently discovered ability to read and understand the character of the people he meets and does business with.

This story is his own, just as he wrote it.

I AM rated as an excellent judge of human nature by those who know me. During the past year (1917) I have built up an organization of more than 250 salesmen. All of these men show an enthusiasm for their work, a loyalty to their organization, and an ability to sell our securities in large quantities which has attracted quite unusual attention and which has meant a great deal to me and my business house in income and prestige.

When I began my business career I little dreamed of the success that would come to me at the age of thirty years. But it did come and I want to tell you—for your own good perhaps—what it is to which I give the credit for my having "found myself" so early.

I should explain right here that I paid the Government last year an income tax of more than $30,000. From this you can easily figure how large my actual income was to justify a tax of that magnitude.

My previous annual income had never before reached $10,000, but from the day that I discovered a simple and scientific system of reading character from outward signs, and of reading my own character and discovering my greatest powers, I knew what the result would be. At least I never felt so confident of anything in my life as that I would turn this new found knowledge into dollars.

As I look back on it now it is a revelation—and quite unbelievable to anyone not "in" on the secret.

People have always tried to read their fellows, attempting to correspond certain physical characteristics, such as the high, narrow forehead of the specialist, the bulging brow of the scientist, the narrow, low brow of the tramp or idler.

This science of reading character at sight, which has meant so much to me, has been reduced to simple, everyday rules of work by Dr. K. M. H. Blackford. In my opinion it deserves a high place in any educational system it is far more important than any other science yet formulated. This is a strong assertion, yet I leave it to you. Do you know anything that is more important in life than knowing how to size up other people? Than knowing how to analyze your own character and make the most of it? Than knowing how to make other people like you? Than knowing how to make people work for you and do your bidding? Honestly—I don't know anything more important, or more likely to make us seize our great opportunities. Do you?

You know as well as I do, from your actual experience, that the men and women who have wasted their lives have usually done this because they were not fitted by nature to do the work attempted. Do you know any sadder tragedies of life? I don't.

Is it any wonder that the statistics show more than 70 per cent of the business ventures of today abject failures?

I am convinced from my own experience that Dr. Blackford's marvelous system of Reading Character at Sight will decrease the percentage of such failures—and therefore increase the percentage of human happiness.

At least I can say, positively, that Dr. Blackford's system has increased my income beyond the point of my fondest dreams.

Just as nature intended that the normal condition of our bodies is perfect health, so the normal condition of everyone is perfect success. We are all meant to be a success at something. We all have the capacity within us to achieve big things in the right line. If we are not a big success, it is merely because we are in the wrong occupation. Napoleon was a failure at authorship. Florence Nightingale failed as a social favorite. Grant was a failure at everything until he became a soldier. These were their wrong occupations. We all have the germ of success within us—the capacity to do big work in some one line. The thing to do is find out what your line of work is.

Dr. K. M. H. Blackford has helped thousands of men find out the work for which they were best fitted to achieve big success. This famous character analyst has been retained at record fees by such corporations as the Westinghouse Electric and Manufacturing Company, Scott Paper Company, The Laurentide Co., Ltd. and many other big concerns, to pick and place rightly the men they employ. And 98 per cent of Dr. Blackford's selections—regardless of their previous experience—made good at the jobs in which they were placed.

Dr. Blackford has helped thousand of others and is now ready to help you. A good many of us are just plugging day in and day out at work we are not naturally fitted to do, work we do not like, work we can never fully succeed at. We swim against the tide, trying to fit our given set of talents to the wrong job. But thru Dr. Blackford, we can now all judge in just what line our biggest success lies. And we can learn the worthwhile secret of knowing, in one quick survey of their features, physique, gestures, and habit of conversation, unerringly the character of every person we meet—of looking into people and thru them, instead of at them.

Thru the little course of lessons in "Reading Character at Sight" now being distributed by Dr. Blackford, we can know, the minute we lay eyes on people, how to make them our friends, in either a business or social way—how to talk to them, how to influence them to the best advantage. Thru the secrets given by Dr. Blackford, we can get a better line on the folks we meet than the friends who have known them for years.

Thousands have already benefited thru the course. Some have decided thru it just what their life-work really is. Others have saved themselves from business disaster and unscrupulous partners. Many others have avoided hiring men whom they knew at a glance to be dishonest and unreliable. Many salesmen use the knowledge they have gained to judge and approach their prospects. Executives use it to deal with and judge their employes. Doctor's use it in dealing with their patients. Lawyers find it of great help in their court work and in their actions, toward clients. Public speakers employ it in judging their audience, and in debate.

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This ability to analyze character immediately and without error can easily be yours. It is not a gift. There is not trick or second sight about it. It is not a supernatural or mysterious power. It is merely the immutable rules of science, practically applied. You can do it as infallibly as Dr. Blackford. This new course in "Reading Character at Sight" in seven simple and fascinating lessons will be sent to you without cost, for examination. You can judge for yourself just what the course will mean to you before you decide whether or not you want it. If you do not believe that it can be of tremendous value to you return it and forget the matter. Otherwise mail its reasonable cost of $5. The coupon printed below will bring you the entire course for free examination without obligation. Use it.

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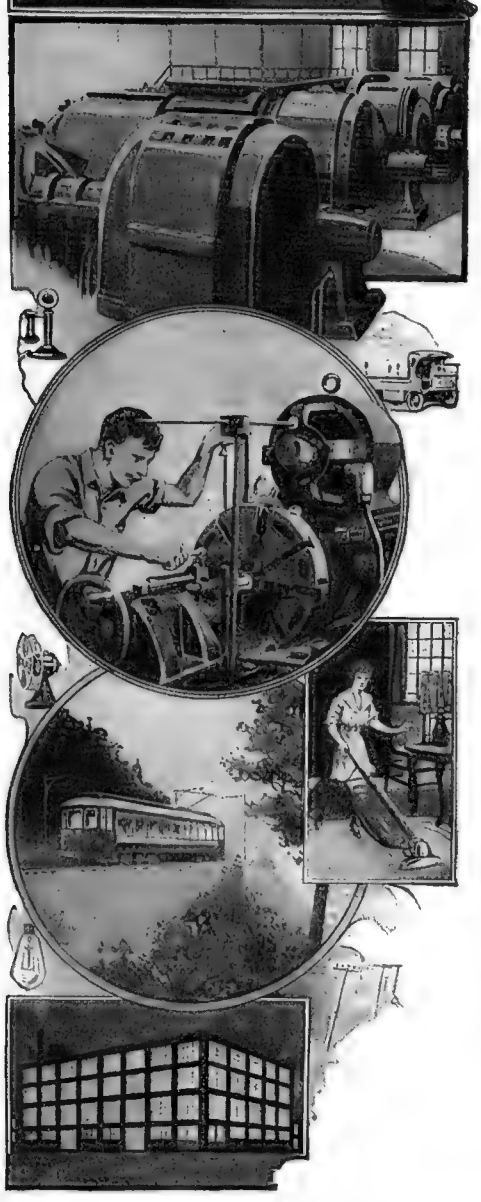

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Vol. VII. Whole No. 83 March, 1920 No. 11

The Airship Of Tomorrow

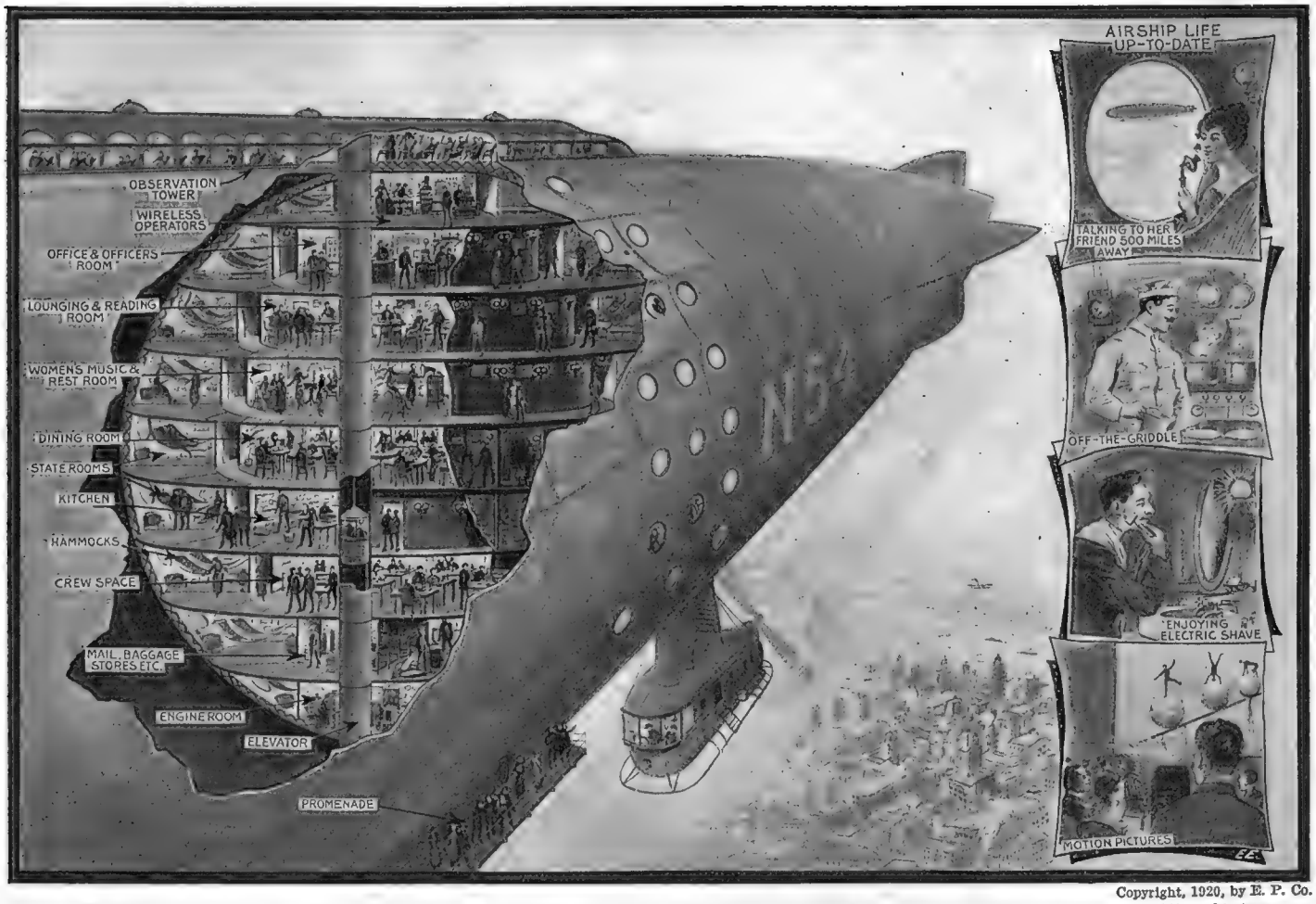
By GEORGE WALL

WE are gradually becoming accustomed to the sight of rapidly increasing sizes of aircraft, especially those of the lighter than air or Zeppelin type, and those who had the good fortune to see the R-34, the gigantic "gas bag" which successfully flew across the Atlantic Ocean from England to America and back, will perhaps expect most anything in the airship of tomorrow. However, there are many developments in a number of these huge aircraft now proposed and being built in various countries that will prove a distinct surprise to those who have not been following the progress of aviation in the past few months.

Already in England and France they have developed and built beautiful airplanes which have a capacity of from thirty to fifty passengers, that almost outrival our finest railroad train appointments in their luxurious furnishings, parlor-car chairs and even to a wash room such as one finds on the giant *Caudron* passenger-carrying plane, recently exhibited at the great aviation salon in Paris. Here we find carpet on the floor and curtains at the windows, with panelled ceilings and electric lights.

The accompanying illustration shows what engineering refinement has done in the perfecting of living conditions for passengers on the latest dirigible or Zeppelin type of aircraft. These gigantic "gas bags" are far larger than one would first imagine, as the picture clearly shows, their height easily accommodating nine stories, equivalent to a nine-story hotel, and they propose to fit the one or more passenger com-

(*Continued on page* 1168)



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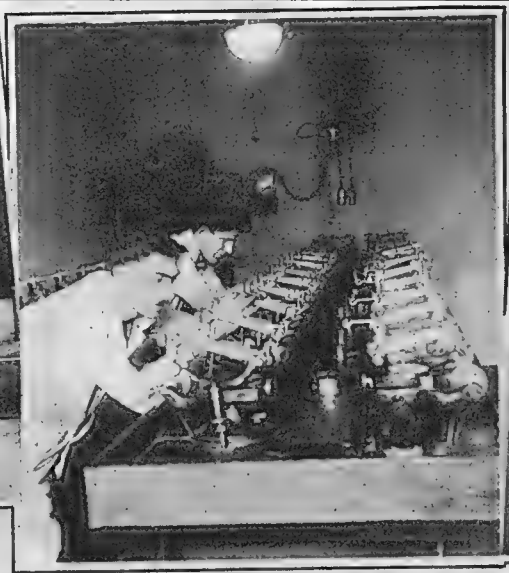
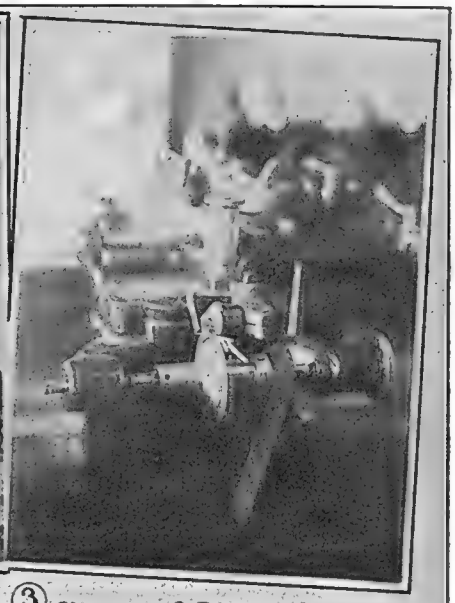
All the Pleasures of City Life Are to Be Found In the Latest Giant Dirigible Aircraft—Even to an Electric Elevator. The Staterooms Are Arranged in Circular Fashion, Which Has Many Commendable Features.

How Diamonds Are Cut

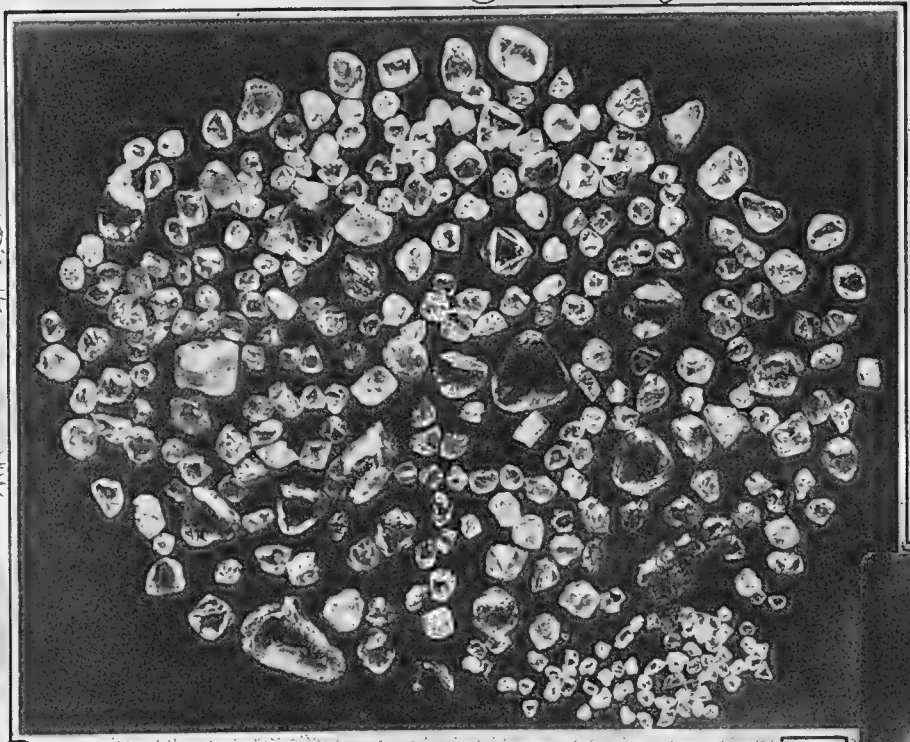
(1) Cleaving the Rough Diamond



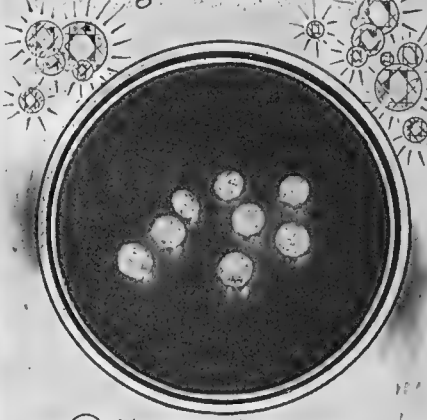
(2) First cutting of Diamond



(3) Close-up of Diamond Cutting Machine

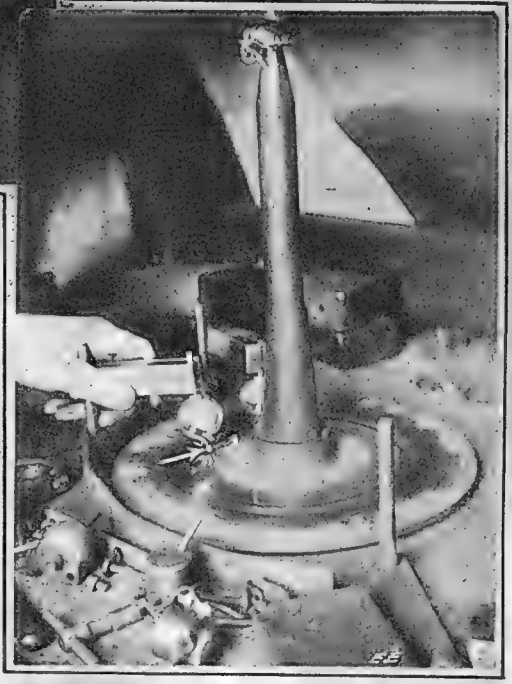


(7) Rough Diamonds (1/4 actual size) from the De Beers Mines weighing 2500 carats. Value $500,000



(6) Finished Diamonds

(4) Grinding Round Edge on Diamond



(5) Grinding Facets and final polishing

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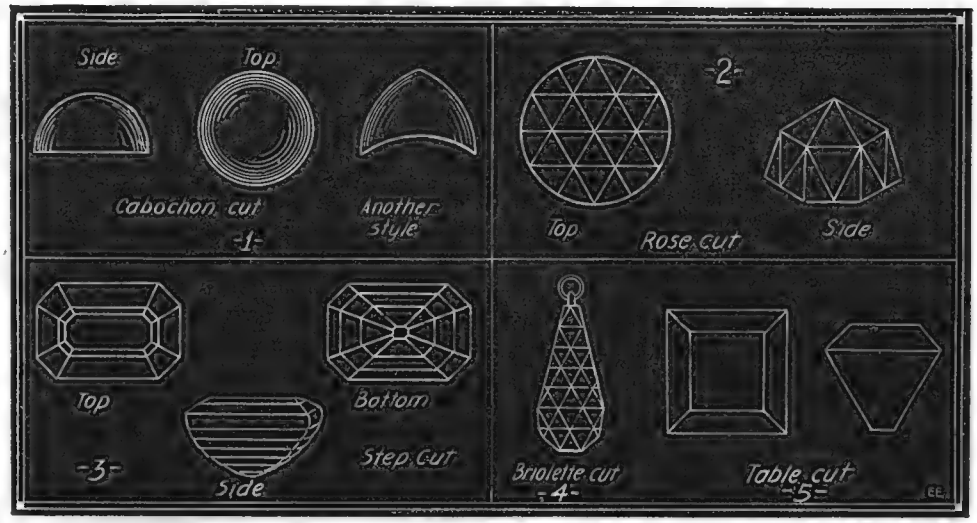
All About Diamonds

By JOSEPH KRAUS

ONE of the most fascinating and popular scientific subjects is that of "diamond cutting," of which very little is known by the general public. The procedure and the amount of technical labor, skill, and remarkable accuracy are only a few of the small items absolutely essential for maintaining the standard of the present diamond trade. The beauty of these stones depends not alone on the stones themselves, but also the method of presentation. The writer has attempted to present here a brief discussion as to what the diamond is and what makes it so valuable, as well as a general description of the interesting procedure followed in cutting a diamond.

A diamond in the pure state is colorless and transparent, but stones of this nature are extremely rare, altho many of the commercial stones of today are purported to be pure white or blue white, when in reality



Here We See the Various Types and Shapes of Diamonds and Other Precious Stones Aside from the Full Cut "Brilliant"—the Standard Shape for a Perfect Diamond Invariably, and Which Is Illustrated Below.

HOW TO TELL A REAL DIAMOND.

(1) Mark the diamond with an aluminum pencil. If it is a real diamond and not a glass imitation the mark may be easily removed by rubbing it briskly with a moistened cloth; if glass, however, the mark cannot be removed, resisting even the action of acids. The surface of the stone for this test must be very clean, which is accomplisht by rubbing with a moistened cloth dipt in whiting.

(2) A nail file if drawn along the edge of a stone will not cut the diamond, while it will cut spurious glass imitations.

(3) The facets have sharp edges, whereas those of glass imitations have much duller edges.

(4) A small globule of water placed upon the table or flat top of a diamond will retain its globular form even if moved about by a pin. It spreads on glass.

(5) By looking at a point on a sheet of paper thru a diamond and a good triplex magnifying glass (i. e., a glass which has been corrected for spherical and chromatic aberration) only one point will be seen if viewed thru a diamond, whereas a number of points or blurred points will be visible if an imitation.

(6) If a doublet or triplet (that is, a false bottom with a genuine top cemented together or a stone made up of three parts), it is detected if placed in oil and viewed from the side.

(7) The finest test of all perhaps is the specific gravity test. This is 3.52 for the diamond. The procedure is described in detail in the article.

No ONE of these tests should be taken as positive proofs, but the entire number may be taken as a fairly good indication of the genuineness of the stone.

objectionable color exists in them which is quickly discernible by the experienced diamond expert. This color is caused by oxids which are present in the crystalline form, and from the chemical viewpoint are supposed to be held in colloidal suspension, altho invisible, even under a microscope.

The presence of iron oxid will cause a yellow or brown or sometimes even a red coloration. For examining diamonds it is necessary that a good North light be present and for the inexperienced, the examination of two stones at the same time will clearly differentiate between the good and the inferior. A clear day should be chosen and an hour between 10 A. M. and 2 P. M.

COLOR IN STONES.

Fancy diamonds are colored stones with well marked shades. Diamonds of this character bring very high prices, for colors are often sought for but what is very *undesirable* is the *slight* tint found in some diamonds which are supposed to be *colorless*. Shades in which the various stones appear are those varying between the following: Red, apple green, violet blue, rather pale saffire blue, absinthe green, golden brown, orange and canary yellow. As has been said before, a pure snow white diamond is very rare and a buyer must be prepared to pay a good price for it if he desires to obtain one.

In order to test for color the diamond is covered by a thin layer of mist caused by giving the same a quick puff of breath. It is then examined with a lens of about one inch focal length, the same being corrected for spherical and chromatic aberration. If held up to the light of an electric incandescent bulb, the stone which allows the filament to be seen the most clearly and which allows the greatest light thru it, is the better stone. Stones are classified according to color and are in order: (1) Rivers, (2) Jägers, (3) Blue Wesseltons, (4) Wesseltons, (5) Top Crystals, (6) Crystals, (7) Very Light Browns, (8) Top Silver Capes, (9) Silver Capes, (10) Capes, (11) Yellow, (12) Brown.

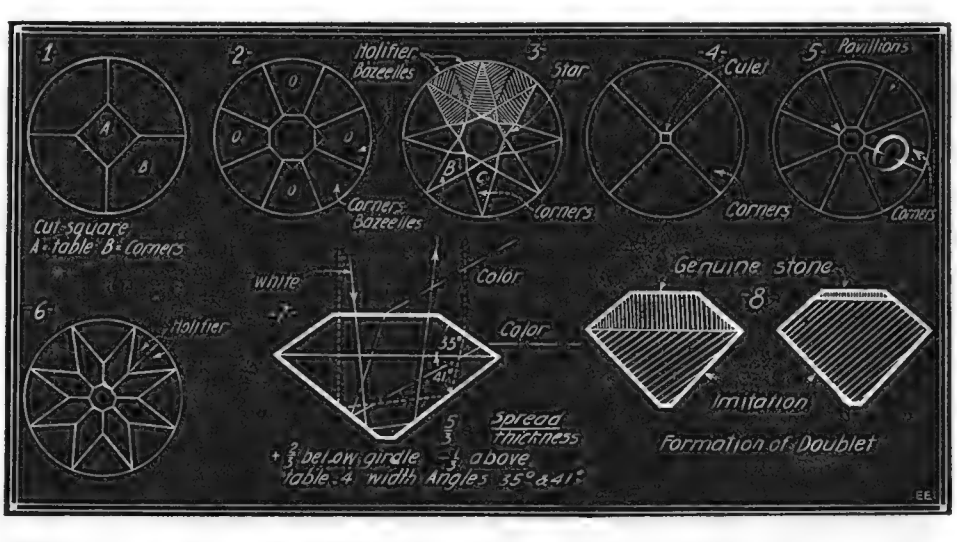
Rivers—these are the rarest, most beautiful Indian and Brazilian stones, altho a few African stones are clast among them. They are pure snowy white or blue white, and are the ones which command the highest price.

Next on the list are the Jägers, of a pale steely blue body color, which is the same thruout the stone. Then come the Blue Wesseltons and Wesseltons, both of which are of a *very slight* yellowish tint scarcely noticeable and together with the Jägers make up the stones of a very high class.

Crystals, however, are poor in comparison with the other stones. If compared with rock crystal or a synthetic white saffire, they appear yellow. Of course, the stone should be dimmed by breathing on it to make this test. Very Light Browns come next. Brown is an undesirable color in stones of this nature, as it absorbs too much light, and so for this reason the stone cannot command as great attention as a stone of a different class.

The Capes are next in order. They are yellow enough to be undesirable and are generally called *commercial white stones.* They are not yellow enough, however, to be pretty and hence, are not so much sought

(*Continued on page* 1172)



Stages 1 to 6—Successive Steps Followed in Cutting a "Brilliant," or Full Shaped Diamond. Fig. 7 Shows Reflection Rays in "Brilliant" and Fig. 8 Formation of a "Doublet."

Power From the Wind

By H. GERNSBACK

FEW people realize the enormous amount of energy locked up in the earth's atmosphere. The amount of latent horse-power available thru the moving air currents in our atmosphere amounts to billions of horse-power annually, and constitutes one of the greatest, if not the greatest, source of energy of unharnest power available to man.

We may say that we have reached the point today where the exploitation of coal is no longer very economic. The reasons for this are manifold.

What we are doing now is to mine the coal at enormous expense, tying up an enormous amount of man power to bring the coal to the surface of the earth. Then we load this coal into trains at great expense, move the trains to far-away points—the average distance being over 1,000 miles for every car of coal. In this we not only consume *more* coal for moving the coal itself, but we block railway traffic with our long coal trains and prevent other more profitable business from taking its due course.

Of course we *have* to do it now, coal being a necessity, and we are willing to pay the price because we must have power—and must heat our houses as well. Nevertheless, the cost incurred in shipping coal from the mine to the great centers is criminal, if we stop to figure out that at the end only *one or two per cent of the energy contained in the original coal is converted either into power or into heat,* the other 98 or 99 per cent having been wasted. As man power gets scarcer and scarcer and costs rise, there will finally come a time when we must turn to other sources for our power.

The writer has in past articles mentioned many other methods upon which man will ultimately fall in his battle against Nature, but in this article we are concerned only in the exploitation of wind power.

This is not a mere dream or a visionary scheme, but there is sound engineering behind it. Wind power has been used for centuries, and the old Egyptians had their crude windmills and propelled their ships by means of wind. In this country air motors or air turbines have reached a high perfection, but they are small affairs, and are only used for local purposes, such as supplying power for private houses, farms, etc.

It is quite practical today from an engineering standpoint to build huge windmills or air turbines which in size would rank with the Woolworth building or the Eiffel tower. Such 1,000-foot monsters, while they may appear somewhat fantastic, are quite within the bounds of reality and it is calculated that they can easily furnish 25,000 horse-power for each individual windmill.

It can readily be imagined what a battery of such monsters would accomplish. Even large cities would only need a few of these giants to keep the entire city supplied with heat, light and power, and the advantage is that it makes no difference geographically where the city is located. Right here the writer wishes to propose a somewhat novel idea which does away with the greatest objection heretofore considered in such "windmill power plants."

In some localities if the energy was to be derived solely from the wind power, of course no power would be had when there was no wind. Take for instance cities located in Arizona, New Mexico, etc., or in other localities where there is no wind for days at a time. Here such a plant, on the face of it, would appear ridiculous for the simple reason that the inhabitants of a city employing such a plant would never know from day to day whether they would have power or not.

Air Turbines Converted Into Hydro-Electric Plants

Of course in most localities this would not hold, but speaking generally, there is a time period in almost any locality during the year when there would be not enough wind to supply the power to the respective cities.

Of course, the idea comes to mind immediately that a solution would be found in the use of storage batteries whereby the electrical power could be stored for emergency purposes. As a matter of fact, most large power houses in the country work on precisely this principle, but if it became a matter of storing enough power in storage batteries to keep a large city going for days at a time, the cost of such a storage battery plant would run up into many millions of dollars. Hence such a scheme at once becomes impractical. Not only this, but the up-keep of such a large storage battery coupled with the great expense of renewing the plates every few years would make the project absolutely prohibitive.

How then are we to overcome this difficulty?

The writer proposes a novel plan to use the windmills or air turbines, not to furnish electrical power direct, but *indirect,* and the underlying idea is as follows:

We will build each air turbine or windmill so large that they will deliver approximately 20% *more power than we require.* Instead of driving our electrical dynamos or generators *direct,* the windmills are not at all employed in this way. *They are used to pump water* from a lower level to a higher one, and for no other purpose. In other words, we first raise the water from a lake, river or other source of water supply, then impound this water into a reservoir. *This then constitutes our supply of power.* From the reservoir large pipes lead to each hydro-electric power station as shown in our illustration herewith, and this water drives the generators of the power stations and from it we take our power.

Now it will become apparent why we have made the wind turbines larger than actually needed. The reason is that we wish to pump up more than enough water and keep a sufficient supply on hand that, even if there should not be any wind for days at a time, we still would have enough water impounded to assure us of a continuous supply of power even tho not one windmill or air turbine was moving.

By making the air turbines larger than necessary (or by using more of them), we accomplish the purpose of impounding an immense reserve of water upon which we do not draw except in an emergency. It is the old story of the honey-bee laying in honey during the summer, which is used during the winter. In other words, while our windmills and air turbines work overtime when there is plenty of wind, we will still have enough water in our reservoir to draw upon when there is no wind.

Basically this scheme is sound from an engineering standpoint. It is simply an engineering proposition, and there is only the first cost of the moderately expensive machinery and apparatus to be considered.

Such a plant should particularly recommend itself to localities far removed from natural water power, also cities along the coast where no water power exists and where the power that *could* be derived from tidal waves is not available as yet.

It is calculated that any company who would make it a business to furnish power from such a windmill hydraulic plant could easily compete with coal even if the latter were selling at a considerably lower figure than it is today.

In our illustration we have shown two types of machines that would lend themselves for the purpose of deriving power from the atmosphere, viz.:

Huge air turbines of from 200 to 400 feet high, each of which can readily furnish 25,000 horse-power while running in a medium wind. The large windmills shown in the insert are not quite as efficient as the turbines, but are much less costly and perhaps easier in maintaining.

We are certain that once such a windmill or wind turbine is built and one locality begins using these huge air machines, the whole country would no doubt follow suit very promptly when the economy of these machines has demonstrated itself. Remember—you get the energy for nothing!

For "April"

Weighing the Earth—Written especially for the ELECTRICAL EXPERIMENTER *by the man who did it—Prof. Louis Derr, Department of Physics, Massachusetts Institute of Technology.*

Physiological Music—How the deaf may "feel" music, by H. Gernsback.

Radium—The Mother of Ionization, by Harold F. Richards, M.A.—a clever and very clearly written as well as illustrated article.

Detecting the Human Body at 600 Feet—How the military engineers developed an instrument which measured the heat radiated by the human body and spotted enemy raiding parties in the dark.

X-Rays of Unprecedented Hardness—A substitute for radium in Therapeutics, by Dr. Alfred Gradenwitz.

Talking Over a Sunbeam—By Prof. A. O. Rankine—the Bell Photophone brought up to date. Specially written for the ELECTRICAL EXPERIMENTER.

The Secret of the Magnet Poles—By Walter E. Keever.

Floating Safe for Ship Mail.

Storage Battery Repairing—By Henry Klaus.

How New York Gets Ozonized Drinking Water.

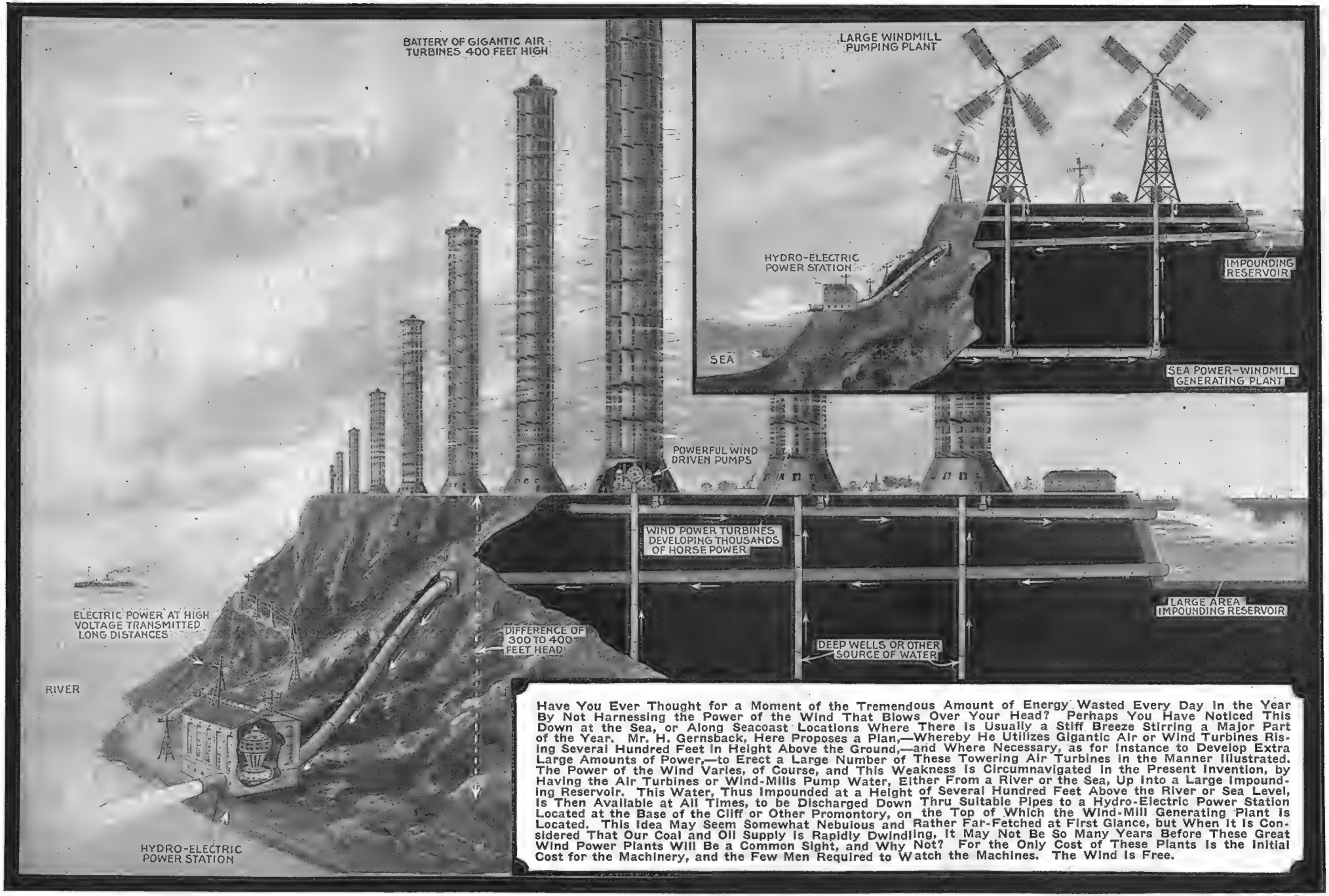
Electrifying Canal Boats and Barges—By Robert G. Skerrett.

Watching Plants Grow with Scientific Instruments—As Well as Measuring and Indicating the Effects of Electric Shocks and Chemicals Applied to Plants. The remarkable work of Sir Jagadis Bose.

Electro-Medical Frauds—By Joseph H. Kraus.

The Dark Searchlight—By Louis Yeager.

NEW HYDRO-ELECTRIC WIND-POWER PLANT


BATTERY OF GIGANTIC AIR TURBINES 400 FEET HIGH
LARGE WINDMILL PUMPING PLANT
HYDRO-ELECTRIC POWER STATION
IMPOUNDING RESERVOIR
SEA
SEA POWER-WINDMILL GENERATING PLANT
POWERFUL WIND DRIVEN PUMPS
WIND POWER TURBINES DEVELOPING THOUSANDS OF HORSE POWER
LARGE AREA IMPOUNDING RESERVOIR
ELECTRIC POWER AT HIGH VOLTAGE TRANSMITTED LONG DISTANCES
DIFFERENCE OF 300 TO 400 FEET HEAD
DEEP WELLS OR OTHER SOURCE OF WATER
RIVER
HYDRO-ELECTRIC POWER STATION

Have You Ever Thought for a Moment of the Tremendous Amount of Energy Wasted Every Day In the Year By Not Harnessing the Power of the Wind That Blows Over Your Head? Perhaps You Have Noticed This Down at the Sea, or Along Seacoast Locations Where There Is Usually a Stiff Breeze Stirring a Major Part of the Year. Mr. H. Gernsback, Here Proposes a Plan,—Whereby He Utilizes Gigantic Air or Wind Turbines Rising Several Hundred Feet In Height Above the Ground,—and Where Necessary, as for Instance to Develop Extra Large Amounts of Power,—to Erect a Large Number of These Towering Air Turbines in the Manner Illustrated. The Power of the Wind Varies, of Course, and This Weakness Is Circumnavigated In the Present Invention, by Having the Air Turbines or Wind-Mills Pump Water, Either From a River or the Sea, Up Into a Large Impounding Reservoir. This Water, Thus Impounded at a Height of Several Hundred Feet Above the River or Sea Level, Is Then Available at All Times, to be Discharged Down Thru Suitable Pipes to a Hydro-Electric Power Station Located at the Base of the Cliff or Other Promontory, on the Top of Which the Wind-Mill Generating Plant Is Located. This Idea May Seem Somewhat Nebulous and Rather Far-Fetched at First Glance, but When It Is Considered That Our Coal and Oil Supply Is Rapidly Dwindling, It May Not Be So Many Years Before These Great Wind Power Plants Will Be a Common Sight, and Why Not? For the Only Cost of These Plants Is the Initial Cost for the Machinery, and the Few Men Required to Watch the Machines. The Wind Is Free.

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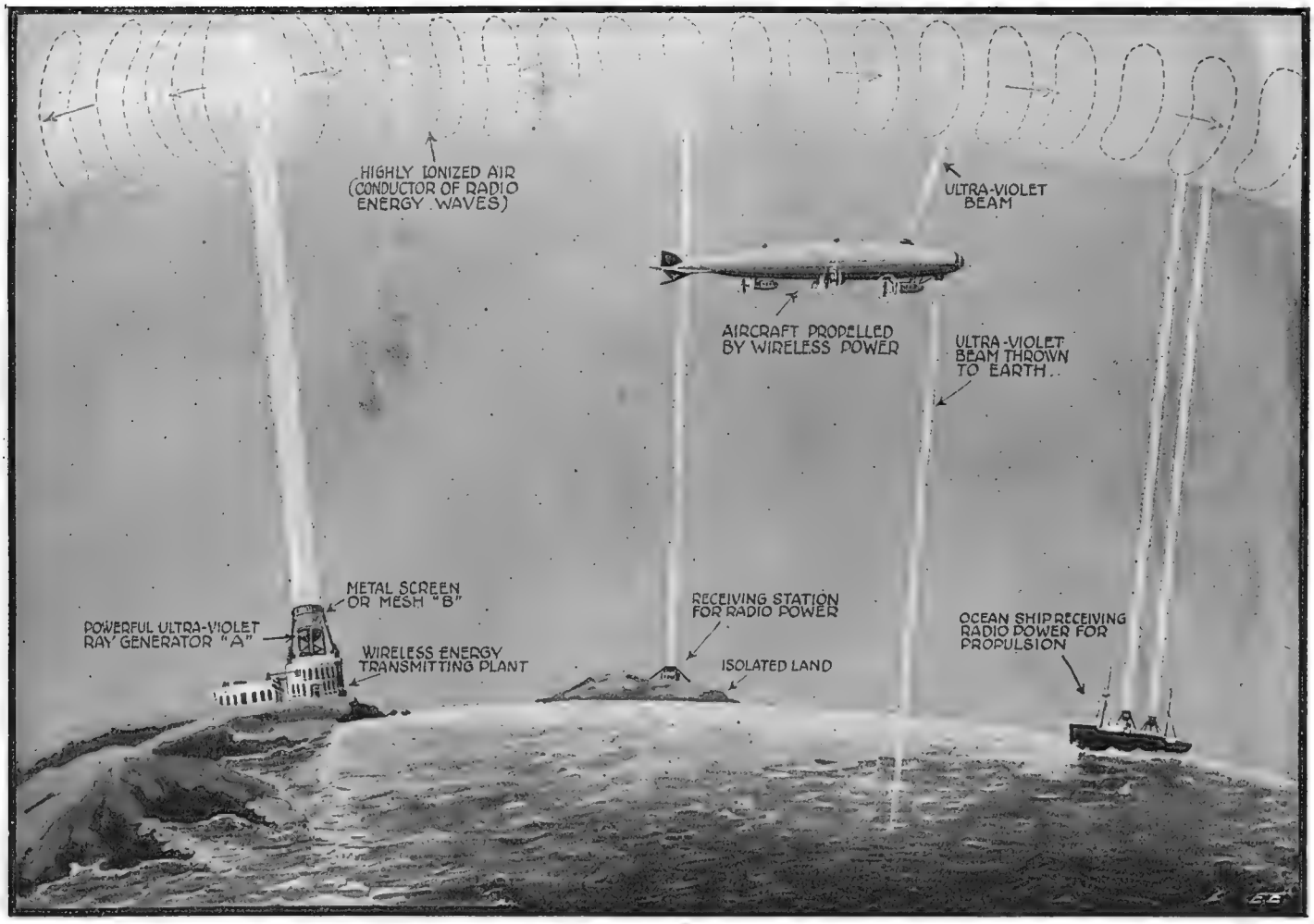

HIGHLY IONIZED AIR (CONDUCTOR OF RADIO ENERGY WAVES)
ULTRA-VIOLET BEAM
AIRCRAFT PROPELLED BY WIRELESS POWER
ULTRA-VIOLET BEAM THROWN TO EARTH
METAL SCREEN OR MESH "B"
POWERFUL ULTRA-VIOLET RAY GENERATOR "A"
WIRELESS ENERGY TRANSMITTING PLANT
RECEIVING STATION FOR RADIO POWER
ISOLATED LAND
OCEAN SHIP RECEIVING RADIO POWER FOR PROPULSION

Showing the Wireless Transmission of Power by Means of Ionized Searchlight Beams. Powerful Tesla Currents of High Potential and Frequency Are Imprest on the Ionized Beams and Received from Similar Beams as Shown.

Wireless Transmission of Power Now Possible

By THOMAS W. BENSON

RECENT developments tend to fulfill the old, old dream of power transmission without wires. For years men have labored in vain to transmit power without wires and thus solve a myriad of transportation problems, such as propelling vehicles, ships, trains, aircraft, etc., without having to include a source of power in their construction. It makes one's head almost reel to think of the possibilities in such an achievement and now the dream promises to come true.

By one bold stroke an English genius, Mr. John Hettinger, has unthinkingly opened up the way for its realization. Like numerous other inventions, the way lay before our very eyes, but we were all too blind to see it.

While working on a means for transmitting radio waves without material aerials, Mr. Hettinger hit upon the idea of using ionized light beams as elevated conductors. Obviously simple when one thinks of it.

It is a well-known fact that an ionized gas is a conductor; in fact, the conductivity of a gas is a measure of its ionization. Furthermore, it is possible to ionize a gas by means of a stream of ultra violet rays. Working with these facts, Mr. Hettinger devised means to utilize them for radio transmission in the following manner.

As shown in Fig. 1, a source of ultra violet rays, an arc or mercury vapor lamp, A, is arranged to throw a beam of ionizing rays vertically.

These rays result in an ionized stream of air that acts as a conductor, the surrounding un-ionized air being practically a perfect insulator. By making connection to this conducting beam with a metallic screen or mesh at B, it can be utilized as an aerial for radio communication.

We are perfectly aware that this ionized beam rapidly loses its conducting power

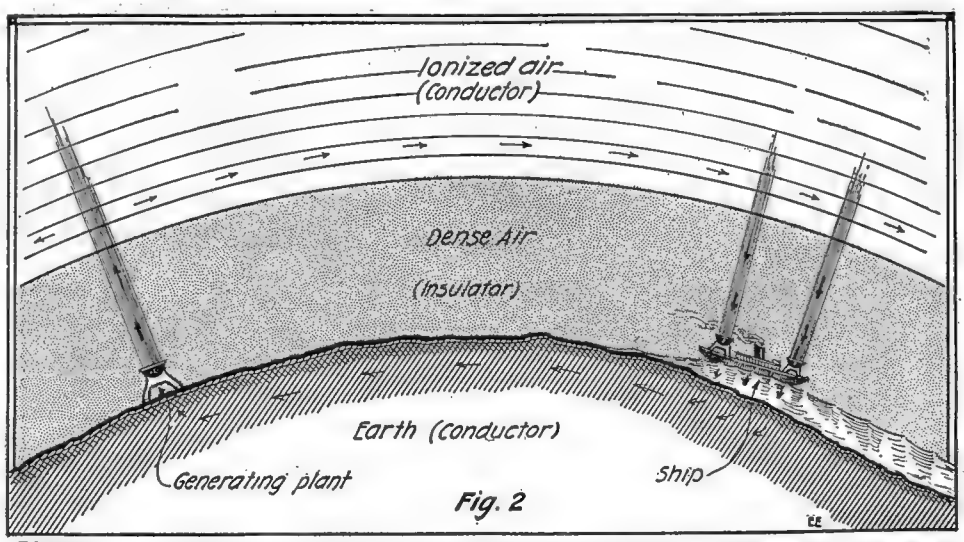


Diagram of the Author's Scheme for the Wireless Transmission of Power Thru Ionized Light Beams and the Upper Ionized Strata of the Atmosphere.

as the distance from the source increases, therefore the effective height of such an arrangement is determined by the intensity of the ray generator. So much for the idea as applied to radio communication.

But let us consider further. In studying the spectrum we find that the sunlight on reaching the earth contains few ultra violet rays of shorter wavelengths than 3,000 Angstrom units, yet we are able to generate much shorter rays with an arc light. It is unreasonable to assume that shorter waves do not leave the sun, and in view of the fact that it has been determined that the upper stratum of our atmosphere is ionized, it is accepted that the shorter rays are absorbed to cause this ionization.

It will now be apparent that a very good condition exists for the transmission of energy without wires. As shown in Fig. 2, we have the earth, a good conductor, surrounded with a blanket of insulating air about ten miles thick, beyond which, up to about a hundred miles, the air is highly rarefied and kept in a state of ionization by light from the sun and stars.

Hence, we have two good conductors separated by several miles of atmosphere, practically a perfect insulator, an ideal arrangement for our purposes. We have but to connect a source of current to the earth and to the ionized strata of air and energy can be transmitted entirely around the earth without wires. The energy could be utilized in any part of the earth by merely connecting to the pair of conductors.

This condition has been recognized for some time, but the difficulty lies in making connections to the upper layer of conducting atmosphere. It is hardly practical to construct towers six or seven miles high for the purpose, then again the energy could not be utilized without using a similar structure at the point of reception, which makes this scheme hardly feasible for aircraft or moving vehicles.

Return then to the ionized stream for radio aerials. We can easily construct arcs that will throw a beam ten or twenty miles. Then why not make connection to that upper stratum with an ionized stream of air? Wonderful in its simplicity.

In Fig. 2 the writer attempts to portray a generating station embodying these principles. In the main building will be housed the generating units for supplying the current to the arc and the primary of the high voltage apparatus for transmission of energy. Supported on the roof of this structure will be a monstrous arc lamp capable of throwing a stream of ultra violet rays for at least ten miles. In this beam is supported a conducting screen to make connection to the conducting stream of ionized air. The insulation of these parts present no great difficulties to modern engineering.

The building will also house a huge step-up transformer, a set of high voltage condensers, a spark gap either of the rotary or quenched type and a huge oscillation transformer or Tesla coil. These instruments are connected in the usual manner and tuned so that the inductance in the circuit and the capacity formed by the earth and ionized upper strata will have a well defined oscillation period.

By these means the whole earth will become an electrified body, energy to be drawn at any point by simply making metallic connection to the earth and pointing a beam of light vertically, a screen being used to take the energy that will flow down the beam. An inductance coil being necessary in the circuit to insure resonance with the transmitter at the receiving set. After once started, the receiving energy can be used to keep the arc going.

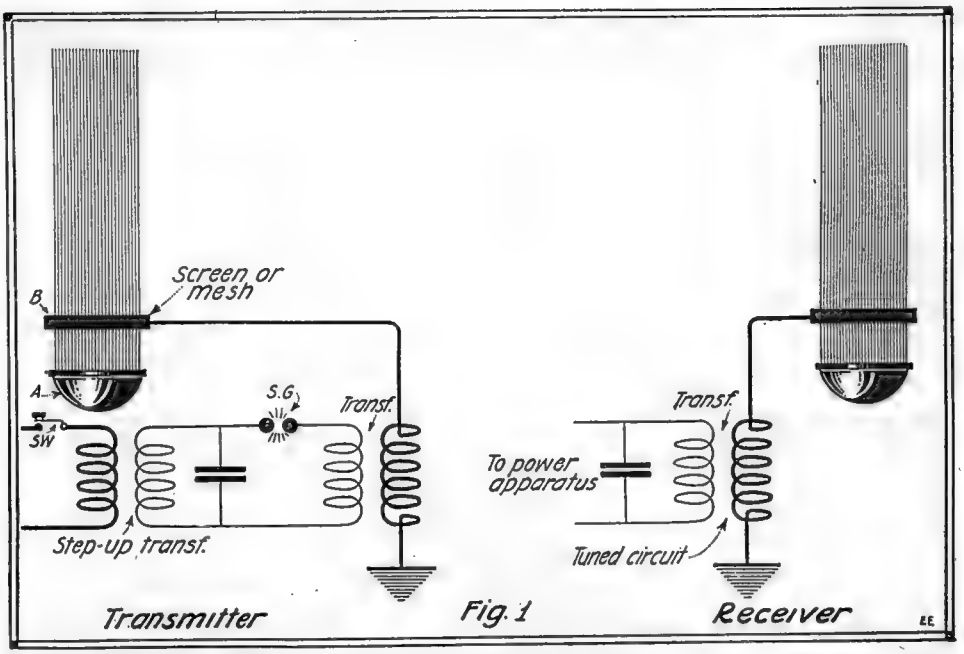


Diagram Showing the Transmitting and Receiving Circuits for the Transmission and Reception of Electric Power by Wireless.

Ships will have an arc and reflector mounted on the masts, aeroplanes have two arcs, one on top, the other below, and so on.

This scheme will not interfere with present short range transmission, it being hardly practical for each home to have an arc on the roof when one arc would serve for a town and several for a large city.

Rather its benefit will lie in the utilization of water falls far from civilization, now unused on account of difficulties in transmitting the power hundreds or thousands of miles.

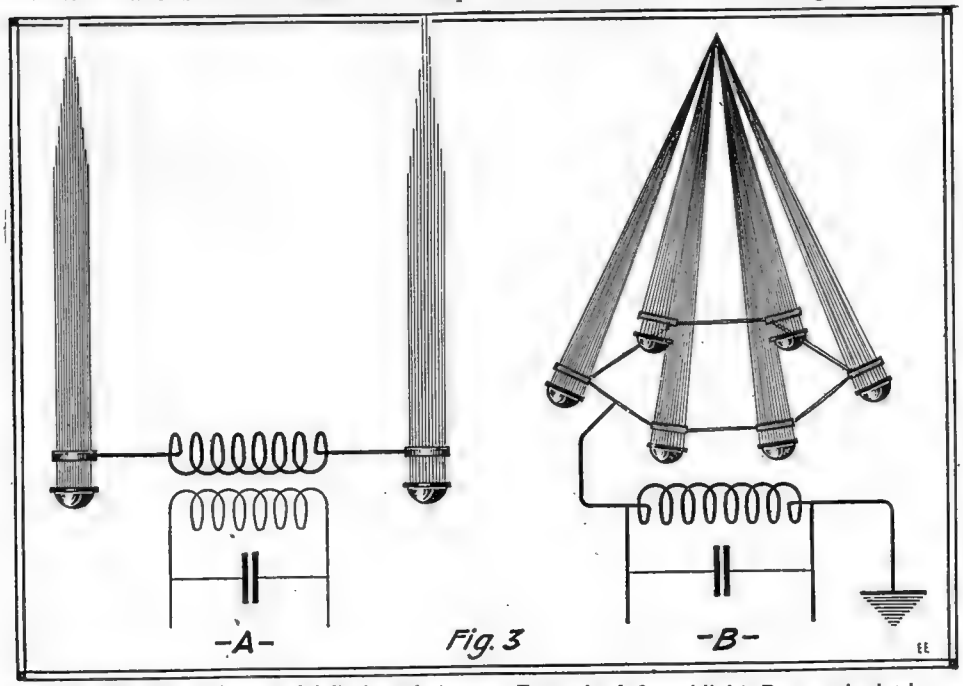
Aside from the transmission of power other advantages may accrue. Will such a stress between the earth and upper air strata reduce the presence of dust particles in the atmosphere? Or, again, cause the immediate condensation of fogs and moisture in the air to give us perfectly cloudless days? Perhaps it will become simply a matter of changing the frequency or voltage of the current to cause rain or to prevent it.

Then the question of effect on radio communication: will it make our present sets obsolete, a transmitter of the future being connected directly to the power set and acting by superimposing different frequencies on the power frequency? Or will radio-telephony work hand in hand with the power system, the voice currents being imprest on the power circuit and filtered out at the receiver?

There are a thousand and one things such an arrangement might effect. Will trees and vegetation increase in growth as experiments in electrical culture would indicate? What effect would such stresses have on germs and bacilli? Their numbers will be decreased by the destructive effects of the ultra-violet light. Will man grow to an unsuspected height and become uniformly healthier due to the electrical treatment he would be constantly undergoing?

And so on—conjecture is without bounds, but the scheme is practical to all appearances; it requires but some financial genius to give it a trial.

And to think it all was within reach such a short time ago! Had Tesla but put a gigantic arc on top of the tower of his experimental station in Long Island accurate data would be at hand now—were it but even a promise it would mean another step towards the final mastery of all matter by man.



Two Optional Forms of Wireless Antennae Formed of Searchlight Beams—Ionized Atmospheric Streams.

War Inventions Disclosed

DURING the War, the various countries, as is well known, have developed a great many apparatus which have been found very useful in the pursuit of the enemy. Most of these ideas have been kept secret, and only of late is the veil being lifted degree by degree.

We take pleasure to present our readers today with four ideas little known before. Fig. 1 shows a device that was very popular with French airmen. It was used to facilitate landing of the fliers, particularly during the night time, when landing, as is well known, is particularly hazardous.

Several months before the war a German by the name of König invented an apparatus which was later improved on by the French, and which works as follows: Two iron or wooden circles are placed vertically one behind the other on the flying field, one circle being slightly smaller than the other. The two circles are parallel to each other, and are separated about 15 feet. The circles themselves are about 10 feet above the ground. Fig. 1 shows this scheme.

The circles during the night are illuminated by means of electric lamps around the perifery. Consequently, from a distance we see nothing but two luminous circles, and it becomes apparent when the aviator is at different heights or different levels, or in a position either to the right or to the left—he will see the two circles in different perspectives from one to the other.

In Fig. 1 in the small insert, the different positions of the rings as they appear to airplanes is shown. No. 1 shows that the aviator is too much to the left and elevated too high for correct landing. In No. 2 it will be seen that the aviator is too much to the left; No. 3 shows that he is too much to right, and No. 4 shows that he is in perfect alignment with the luminous circles and will make a perfect landing. This position would be considered ideal. No. 5 shows that the aviator is away too high—in other words, in the position shown of the second airplane in our illustration. The first airplane will make a perfect landing. The third airplane would be too much to the left as well as too high. By studying the figures in our illustration the result will become apparent.

Fig. 2 shows what has been termed the "Tele-Periscope." By means of this apparatus, first used by the Germans, it is possible to see at a great distance, inasmuch as the slender metal skeleton which is painted gray merges into the sky, and at a little distance the enemy has great difficulty in seeing the periscope. Furthermore, the entire contrivance is mounted on a sort of carriage which can be attached to an automobile moving from place to place, so there is little danger of an enemy shell reaching and destroying it. It will be noted that in the large periscope shown the light rays do not come thru the skeleton tube but pass thru the open air, as indicated by the dotted lines. This was found to be quite possible, and while the picture obtained in this manner is not absolutely perfect, still it was good enough to observe the enemy and his doings.

Fig. 3 shows an aerial signaling apparatus used a good deal by the French during the war. By means of an air blast and soot chamber it became possible for the pilot or his assistant to send Morse code signals *in smoke* to the observers below. This is clearly shown in our illustration, which also shows this apparatus in procedure better than words can.

The great trouble with this arrangement is that unless the aviator is well behind friendly lines the enemy, by means of powerful field glasses, can read the dots and dashes as well. Of course cipher messages were used mostly, and thus it made but little difference if the enemy saw the signals or not.

Fig. 4 shows the well known Le Boulangé chronograph to measure the speeds of shells and bullets. The principle of this apparatus is to measure the time which elapses between the rupture of two metal wires stretched between frames, which latter are in the line of a projectile as shown in our illustration. The frames are

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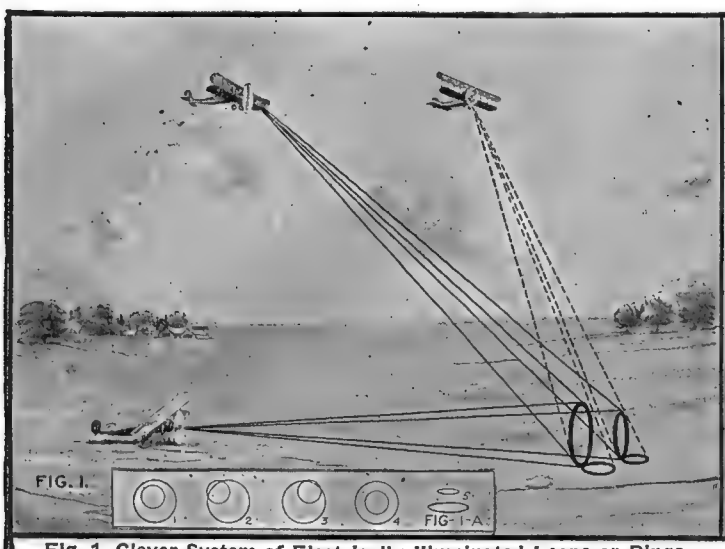


Fig. 1. Clever System of Electrically Illuminated Loops or Rings to Guide Airmen in Making a Safe Landing at Night.

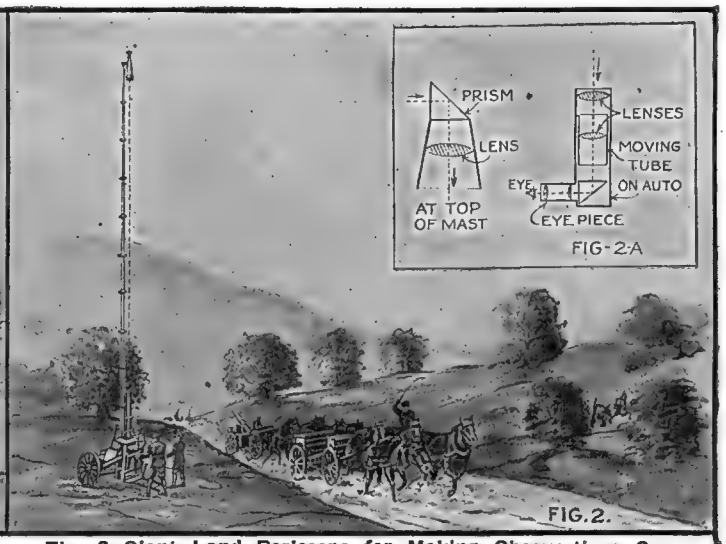


Fig. 2. Giant Land Periscope for Making Observations Over Long Distances. The Image Is Projected Between Lenses Thru the Air.

Fig. 3. A War Device—Aerial Signaling by Smoke Puffs Between Airplanes or Airplanes and Earth.

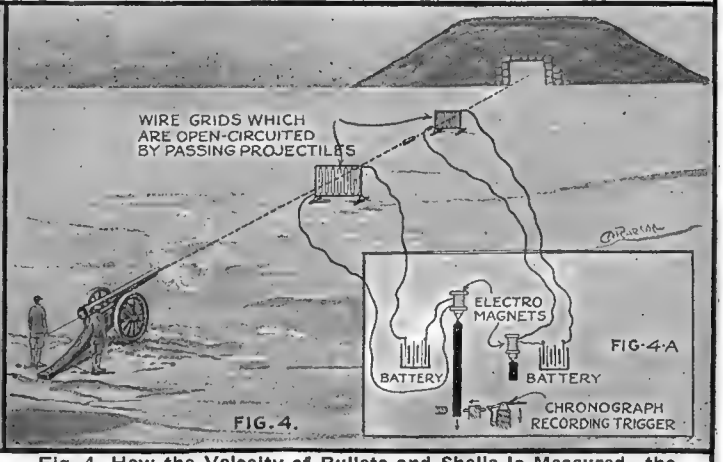


Fig. 4. How the Velocity of Bullets and Shells Is Measured—the Projectile Breaks Two Grids Consecutively, the Chronometer Accurately Registering the Intervening Time.

Huge Siphon Tidal Power Plant

By H. WINFIELD SECOR

How Sea Water is Siphoned into and out of Reservoir, Developing Electric Power Either Way

FROM time to time, some budding genius comes out before the world with a startling invention with which he proclaims that he intends to harness the power of the ocean waves or the power of the tides, whether these be created by ocean, river or lake action, primarily. Most of these schemes die a natural death while reposing in the vaults of the U. S. Patent Office, even tho the patents may eventfully be issued on the more or less successful looking inventions.

One of the most ingenious ideas that has been proposed recently in the realm of tidal power plants is the one illustrated herewith, and which has been invented and patented by Mr. Charles Herbert Talmage of New Bedford, Mass. The inventor certainly deserves a great deal of credit for the way in which he worked out the various details of this tidal power plant and the means for applying it in practise, especially in the clever construction of the collapsible dams, which are caused to rise and fall by water pressure.

The accompanying illustration shows clearly just how Mr. Talmage proposes to reap useful power from the gigantic tidal actions occurring along our great sea coasts and other locations such as along rivers. In brief, the principle underlying the operation of this tidal power plant is as follows:

By referring to the small detail illustrations herewith, it will be seen that as the ocean tide rises, for example, that the water within the large reservoir or tidal basin will be at a lower level. As the ocean tide proceeds to slowly rise, the sea dam is raised by hydrostatic pressure or water pumped into it by suitable means, while the turbine float with its two or more attached siphoning pipes rises correspondingly. All the while water is flowing from the sea up thru the siphons and out thru the turbines into the tidal basin as shown by the arrows.

In the first place, the siphon action is created by exhausting the air from the left hand siphon, thru the small pipe connecting the tops of the two siphons, and which is joined to a suitable exhausting apparatus or machine, not shown. This action keeps up until the sea tide has risen to its highest level and shortly after which period the level of the water in the tidal basin will have risen to a similar height.

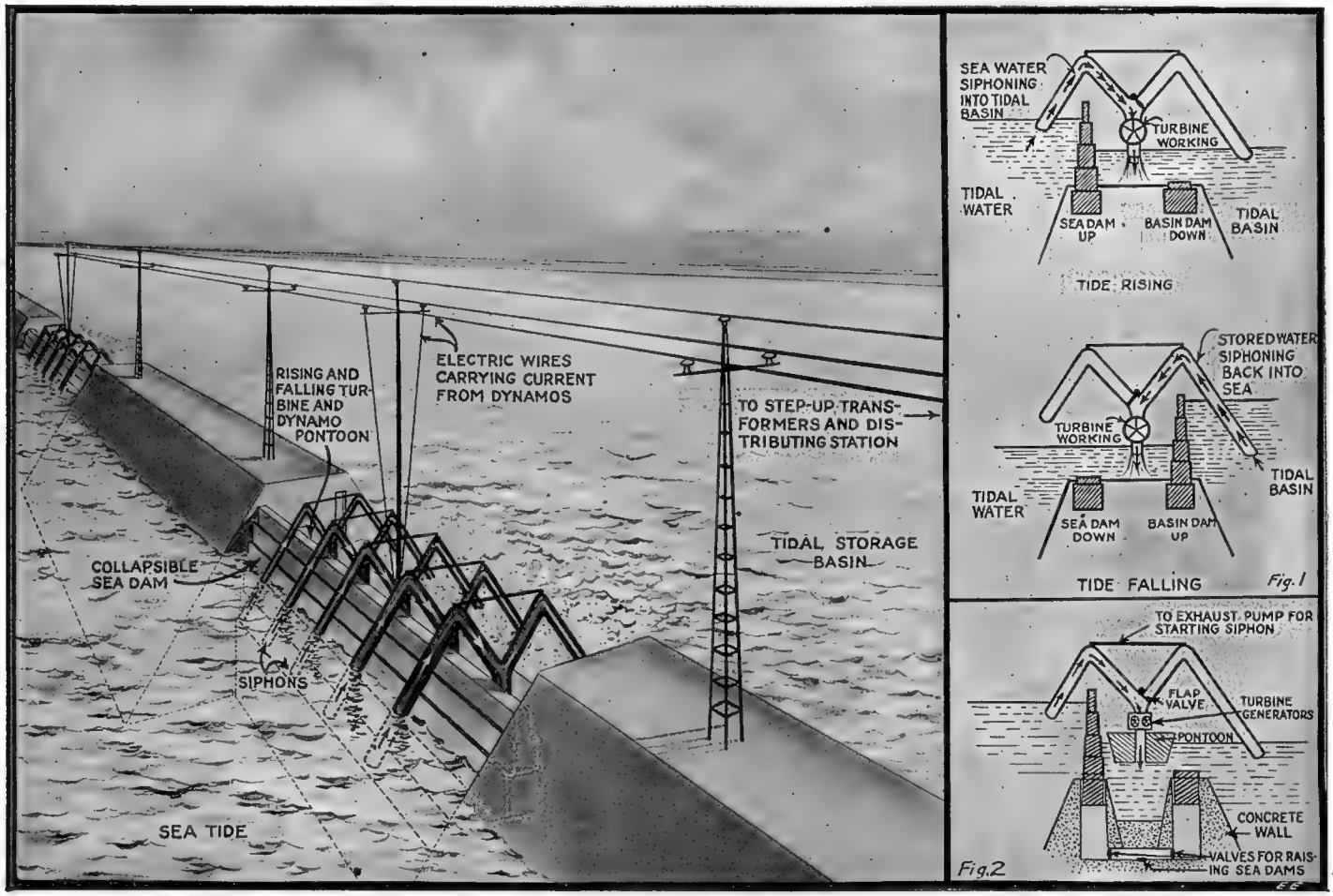
As soon as the sea tide begins to fall or ebb, then the reverse action is set up by opening the valve at the basin siphon just above the turbine, and closing off the left hand siphon, as clearly shown in the second detail illustration. A vacuum is created in this siphon by the action aforementioned, and the water is caused to flow from the tidal basin, into the right hand siphon, down thru the turbine and into the sea again.

The pontoon containing the turbines and dynamos falls with the sea tide, and the basin or right hand dam is slowly collapsed by emptying the water out of it. In this way power is developt practically all the time, while the sea tide is rising and while it is ebbing, and useful energy is thus realized from the tidal power itself, without any expenditure of money for coal or other source of energy, the only actual expense being that for the operating personnel and the initial cost of the installation of the machinery and dams.

As the large perspective view shows, a substantial and adequately strong wall has to be erected along the sea front, to withstand the pounding of the waves and also to serve as a restraining wall for the impounding reservoir and the millions of cubic feet of water which would be siphoned into it from the sea. The inventor's designs call for siphon, turbine and generating units mounted in groups of five, which is a very good idea, and several of these units can be grouped along the sea wall in the manner illustrated.

At the present time, engineers and others are rather wont to scoff at what to them appear to be radical and impractical tidal

(*Continued on page* 1178)



Remarkable New Tidal Power Scheme Utilizing the "Siphon" Principle—the Water Is First Siphoned from the Sea Into the Impounding Reservoir and Afterward, on Falling Tide, Siphoned Back Into the Sea. Either Way the Turbines and Dynamos Extract Their Quota of Energy from the Flowing Water.

Trapping With a Mouse Trap Camera

By HOWARD TAYLOR MIDDLETON

A Snapshot of Br'er 'Coon—One of the Hardest Animals to Photograph. It's Easy With the "Mouse-Trap" Scheme Here Described.

FOR a long time Mrs. Middleton and I had induced birds and animals to photograph themselves thru the medium of a bit of thread stretched from camera shutter to bait, and, while we had obtained numerous successful pictures, we often failed to get a good portrait, due to the blurring of the subject caused by movement. We used a Premo camera with rapid rectilinear lens, maximum shutter speed 1/100 second, and this was not fast enough to make a sharp image certain under all conditions. In order to overcome this difficulty, we realized we must use our Graflex camera which would shoot as fast as 1/1000 second if desired. However, here we met with, what seemed at first, an unsurmountable obstacle: The focal plane shutter of the Graflex does not release with a hair-trigger pull like the Premo shutter, but with a *steady downward pressure*, and we doubted very much whether a small animal or bird would have the strength to operate it.

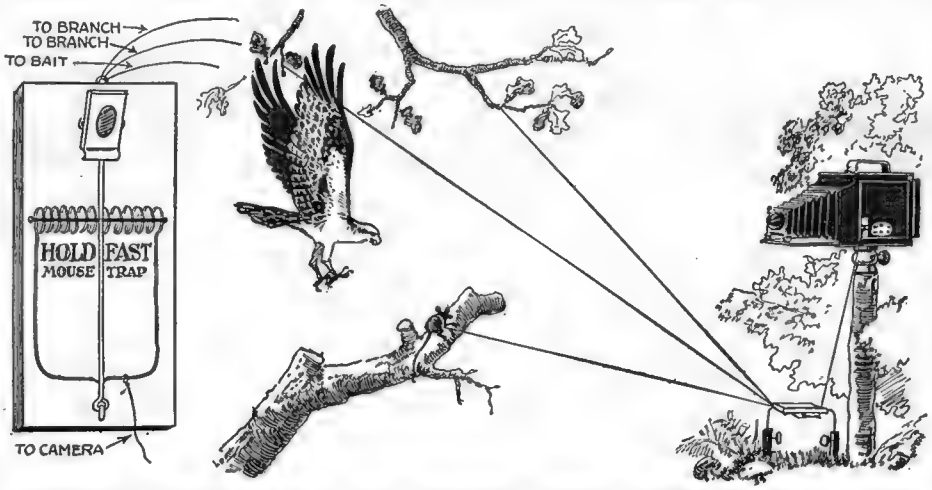
What we needed was a piece of mechanism with a hair-trigger at one end and a strong pull at the other, and we have found this in a 5-cent mouse trap! Clampt in position directly beneath the Graflex, with thread running from wire loop of trap to camera shutter trip, and from pedal of trap to bait, the apparatus is ready for action.

We will not venture far afield to try out our mouse trap camera. There are barn rats down in the granary; we ask you to accompany us in an endeavor to induce one of the furry tribe to present us with his portrait. We set up our camera outfit just outside the granary wall, place the mouse trap in position, connect the thread, at the end of which we hang a tender morsel of meat, and depart for an hour or so. Upon our return, we find the thread broken and bait gone. Development of the negative brings up the image of Mr. B. Rat, Esq., in the act of partaking of our hospitality. He is a thieving rascal, no doubt, but he is a gentleman as well in so far as his table manners are concerned. (See illustration.)

We know of a snug nest beneath a windbreak in the deep woods where Br'er 'Coon snoozes the daylight hours away. Let us set up our mouse trap camera along his trail. Then as he emerges from his den, stepping daintly forth to greet the golden rays of the westering sun, his hand-like fore-paw touches the thread. Thud-snap! goes the mouse trap camera, and with a whoof! of surprise a fluffy gray ball of fur flashes away thru the forest glade, flinging the autumn leaves in a multi-colored shower from beneath his flying feet. He has left his portrait with us, however, and we are satisfied.

Mr. Barn Rat, Esq., Photographed in a Thoughtful Pose by the "Mouse-Trap" Camera. Lifelike, Isn't It?

Birds as well as animals can be trapt photographically as described above. That brigand of the air, the hawk will gladly pose for you if you will place a mouse or an English sparrow upon a limb for his benefit. In this case, use three threads instead of one, two running to overhead branches and the third to bait. (See sketch herewith.) By this method, if his wing should touch the thread before he reaches the bait, you will catch him in the air—a unique portrait, indeed.



By Rigging Up the Mouse-Trap With 3 Strings the Graflex Is Easily Operated by a Bird Attracted by Bait.

French Radio Station to Have 13,000-Mile Range

At an early date France will possess a wireless station capable of sending messages everywhere on the world's surface. This station, now nearing completion at Bordeaux, will have sufficient power to reach all stations within a radius of approximately 13,000 miles.

The Eiffel tower station and the immense government station at Lyons have been France's important stations thruout the war. The Eiffel tower was able to send messages up to a distance of 3,500 miles, while the new station at Lyons had an average range of about 7,000 miles.

An average of 10,000 words per day have been sent out from Lyons thruout the war. It was from this station that many parts of the world were kept informed of the war's progress, even the Far East getting its western front news from this station's messages which were picked up in Shanghai, and there given to the local papers.

The Bordeaux station has been jointly constructed by Americans and French. When General Pershing arrived in France he requested a station which would enable him to keep in touch with the United States at all times regardless of bad atmospheric conditions. The Bordeaux site was immediately suggested by the French government and work begun under the direction of General Ferrie, of the French telegraphic service. Nearly 1,000 French and American soldiers were assigned to the task of constructing the immense station.

In actual electrical power supplied the antenna the capacity of the Bordeaux equipment will be five times as great as the Eiffel tower and three times as great as the Lyons station. Fully 500 kilowatts will be available for transmitting the messages. This will be far the greatest electrical force ever devoted to the radiation of wireless news.

The famous German station at Nauen, heretofore the most powerful in Europe, will be greatly outdistanced, both in sending distance and in daily capacity. The Bordeaux station will be able to send 50 words per minute, or a total of 72,000 per day. The great capacity will be made possible by the employment of special equipment heretofore confined to wire telegraphy.

Sixty men will be needed to maintain and operate the station. They will work in four shifts, keeping open a continuous twenty-four hour service.

NOVEL ELECTRIC STUNTS

Did You Ever Play Phonograph Roulette? A Cardboard Wheel of Fortune Is Placed on the Disc and a Metal Stop Is Fixt at the Side. A Sewing Machine Motor Runs the Phonograph Electrically.

The Curling Iron Is Not Solely a Thing of Vanity. It May Be Brought Into Extremely Practical Use as a Pressor of Garments. When Used Closed, the Curling Iron Makes the Hem In the New Skirt Look as Thoroly Prest As with a Sad Iron.

An Electric Curling Iron May Be Used to Advantage As an Immersion Heater After Thoro Washing, of Course. The Bachelor Maid May Heat a Can of Peas, Corn, Beans, etc., Right In the Can

The Remarkable Heat of the Nitrogen Lamp Is Ordinarily Wasted. A Nitrogen Lamp Soldered Into a Dipper When Held Over Eggs Will Cook Them In Three Minutes. Butter Should Be Spread Over the Top of the Yolk So That It Does Not Harden Before It Is Cooked

Extend the Camera Tripod and You Have a Fine Floor Lamp for Reading or Piano

The Tripod Is Now Invading Other Fields Aside From That of Photography. It May Be Made Surprisingly Useful in the Home as a Reading Lamp for the Table

An Inexpensive Electric Heating Pad — An Electric Light Bulb Is Put Into a Mason Jar and the Wire Is Run Thru a Hole Made In the Metal Top. This Makes a Perfectly Safe Bed Warmer, as the Heat Is Moderate.

Lighting the Gas Electrically Is Now Made Possible By the New "Violet Ray" Generators on the Market Used to Relieve Pain. The Series of Small Sparks Does the Work Instantly

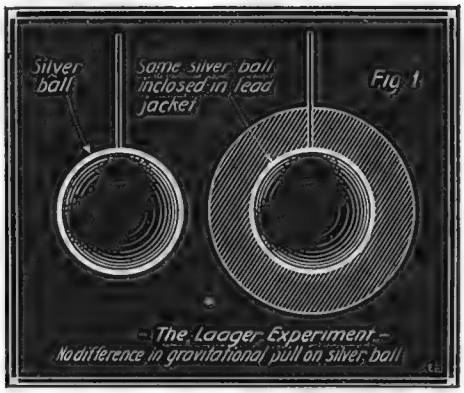
New Researches in Gravitation

By PROF. QUIRINO MAJORANA

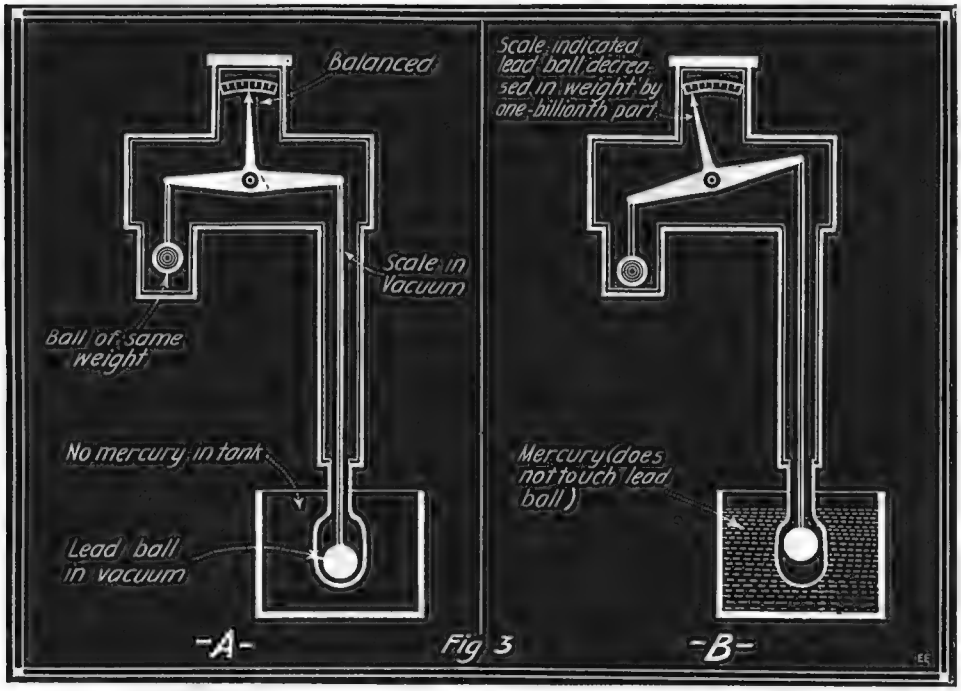
TRANSLATED FROM THE ITALIAN BY ARTHUR BENINGTON

THE new theories and new facts set forth here were brought out by considerations in the field of cosmogony as well as in that of physics, properly so-called. In the field of cosmogony it is possible to observe quite closely. It is well known that examination of the light emitted by celestial bodies enables us to classify these into white, yellow and red stars, in addition to double stars, stellar masses, nebulae, spiral nebulae, etc. Now we know from observation that the white (with very high temperature) are about 60 per cent of all the stars; the yellow (about 6,000 degrees, like our sun), 35 per cent and the reddish only 5 per cent. The temperature of the stars is deduced from spectroscopic observations—experiments with the various types of spectra, i. e., the continuous spectra and the bright line spectrum. The result is that the red stars are very few in number. On earth or, at most, like Jupiter (respectively 1/1,000 and 1/333,000 of the solar mass).

If the origin of the several solar systems of the universe had been accidental and had taken place at very different epochs, it would be logical to suppose that a number of stars much greater than 5 per cent would present themselves with the low temperature of the red color, and besides that many others would be completely extinct. To explain this state of things one willingly recurs to the idea of God; that is, to a supernatural hand which created the universe with all its worlds contemporaneously. But evidently this idea is exiled from the field of positive science; its introduction would constitute only a simple criterion and, altho I do not say that the naturalist must be an atheist, it is certain that he should not abuse this too convenient idea, for he would not further the progress of experimental science or of


Silver ball
Same silver ball inclosed in lead jacket
Fig. 1
The Laager Experiment—
No difference in gravitational pull on silver ball

In the Laager Experiment, the Lead Jacket Placed Around the Silver Ball Did Not Cause Any Decrease in Its Weight—Due to the Scale Not Being Sufficiently Accurate, Prof. Majorana Believes.



Simplified View of Prof. Majorana's Vacuum Scale and Mercury Container for Weighing a Lead Ball, First Without Mercury Surrounding It—Full Gravitational Pull—and Second, With Mercury Surrounding, but not Touching Ball; the Mercury Absorbing Some of the Gravitational Force.

what theory can this be explained? The idea most generally accepted by astronomers is as follows: The several suns of the universe had origins similar to that of our solar system; this is defined according to the hypothesis of Laplace; therefore, it is a matter of nebulae that, gradually condensing, give place to the formation of a central sun with its own planets and satellites. Now as these systems, with the passing of millions of years, go on progressively cooling, they should present themselves to us to-day with widely differing temperatures. So, according to this hypothesis, it seems strange that only 5 per cent are made up of red stars; that is to say, stars that are relatively cold or approaching the phase of extinction.

Besides, according to certain theories of thermo-dynamics that would compare the universe to a mass of worlds like the molecules of a gas, it seems we can exclude the possibility that dark celestial bodies, that is stars without light, exist in the heavens. This, be it understood, if we ignore certain small bodies in size about like our observation. Therefore, I say that we must seek another explanation of the constitution of the heavens.

Without leaving the field of cosmogony, let us turn our attention to the origin of solar heat. The controversy is well known; neither the theory of chemical origin nor that of the fall of meteorites at 616 kilometers a second can explain the enormous quantity of heat constantly emitted by the sun. It was Helmholtz who advanced the most generally accepted theory of solar heat: He supposes that the sun is gradually contracting, that this considerably slows down its cooling and creates a new source of heat. Unfortunately, physicists are able to calculate the extreme limits that the sun's life may have if such contraction be admitted. Poincaré has made the calculation and finds that the sun could not be more than fifty million years old. Now, according to Laplace's hypothesis the earth, having been detached from the central mass of the nebula which was the sun, must have an age certainly no greater than that of the sun. On the other hand, there are indications offered to us by the geologists and biologists which give us reason to believe that the earth may have an age notably greater than the 50,000,000 years deduced from Helmholtz's theory. These indications are based upon a study of the numerous sedimentary strata of the earth, of the corrosion of chains of mountains which once were like our Alps and now have disappeared, of the saltiness of the sea and, in another field, of the time required for the evolution of animal and vegetable species. Thus some have succeeded in establishing that the earth cannot be less than a billion years old. So Helmholtz's theory, the only acceptable one up to the present, is defective.

The considerations made by me in the field of physics are of an entirely different order of ideas.

They refer to the law of universal gravitation, the famous law of Newton. This law teaches us that two material masses attract each other in direct ratio to their mass and inversely as the square of their distance. This law governs the movements of the stars; to this law is due the fact of the weights of bodies. Cavendish, an English physicist, proved in the laboratory, after Newton, the phenomenon of the attraction between two masses. The Cavendish balance enables us to see that two bodies, one of about one kilogram, the other of about one gram, attract each other with a force of about 3/1,000,000 of a milligram; the force that the earth exerts upon this same gram is 300,000,000 times greater.

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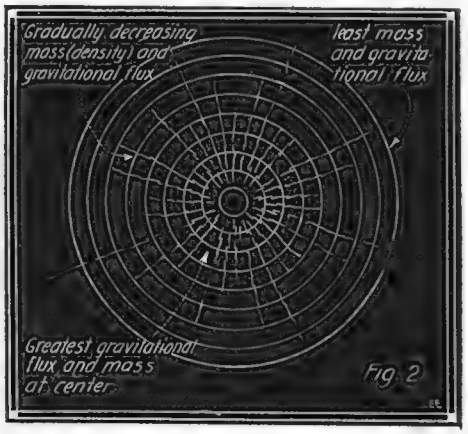
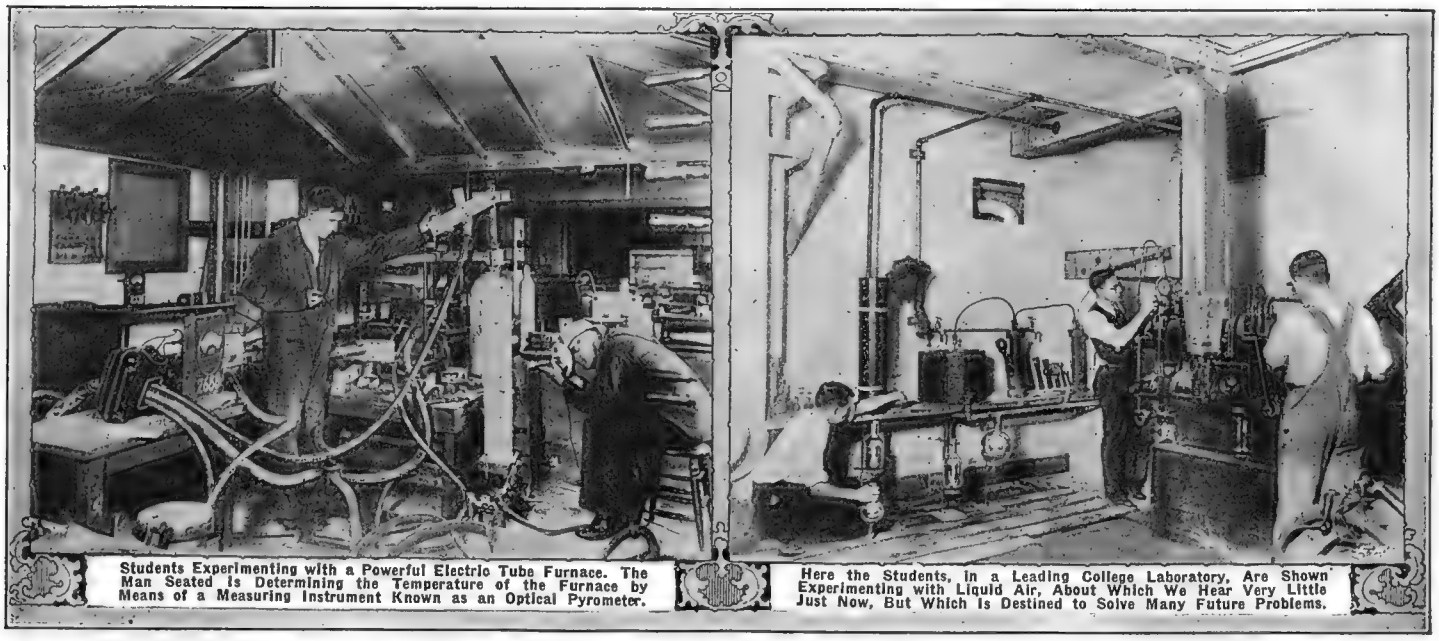

Gradually decreasing mass (density) and gravitational flux
least mass and gravitational flux
Greatest gravitational flux and mass at center
Fig. 2

The Author Believes that the Highest Density and Gravitational Flux is at the Center of the Mass as Here Shown.



Students Experimenting with a Powerful Electric Tube Furnace. The Man Seated is Determining the Temperature of the Furnace by Means of a Measuring Instrument Known as an Optical Pyrometer.

Here the Students, in a Leading College Laboratory, Are Shown Experimenting with Liquid Air, About Which We Hear Very Little Just Now, But Which Is Destined to Solve Many Future Problems.

Modern Schoolroom Science

TWENTY years ago we studied Science in the schoolroom and college, to a great degree at least, from the text-books. To-day the embryo scientists play around with such simple little things as "liquid air," "radio telegraphy," "electro-chemistry," etc. The photos herewith show two interesting laboratory scenes taken at one of America's leading engineering schools.

The liquefaction of air on a commercial scale came with the invention of the modern high pressure air compressor. The compressor shown on the right in one of the photographs is compressing air to 3,000 pounds per square inch which is roughly 200 times ordinary atmospheric pressure. The air then cools by expansion in tubes immersed in cooling agents seen in the center of the photograph. The air is forced thru this process again until its temperature has been lowered to 310° F. below zero, at which point it becomes a liquid and is drawn from the cylinder at the left. The use of the liquid air in scientific research is as a cooling agent. By placing the substance to be experimented on in a tube and immersing the whole in the liquid air the behavior of different substances under various conditions at extremely low temperatures can be determined. A study of the properties of different substances at temperatures in the region of the absolute zero, i. e., the temperature at which gases cease to exert pressure, has been a fruitful source of information in developing modern theories of matter.

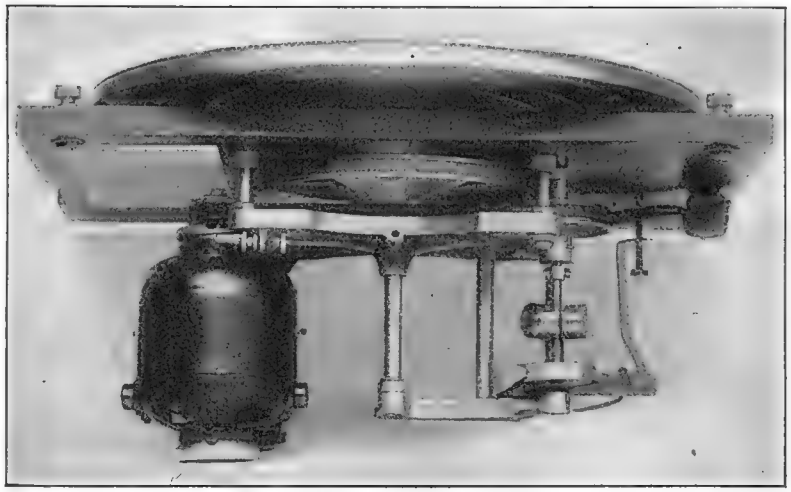
In industry liquid air is used as a source of pure oxygen, which is obtained by a process of fractional distillation in taking advantage of the different boiling points of liquid oxygen and liquid nitrogen which are the two principal constituents of air.

Liquid air and liquefied helium have done their bit toward helping to solve some of the world's greatest scientific mysteries. Onnes, by placing an electric circuit in liquefied helium, reduced its resistance to approximately absolute zero, and a current, once started in the circuit, kept on flowing, almost like perpetual motion, for over twenty hours. Liquid air freezes or solidifies mercury and is used extensively in exhausting X-ray and audion bulbs to the highest degree.

Our second photo shows industrial research with an electric tube furnace. A great industry has grown up around Niagara Falls, where enormous water-power is available for transfer into electrical energy, in which application is made of the chemical effects of electricity. It is the so-called electrochemical industry and in it the electric furnace stands supreme as a magic crucible in which chemical wonders are performed. In the photograph students are shown operating an electric furnace of the "tube type" which they have themselves constructed. The man seated is determining the temperature within the furnace by an optical method, depending on the measurement of the light-giving power of an incandescent body under certain standard conditions.

Phonograph Runs 2500 Years

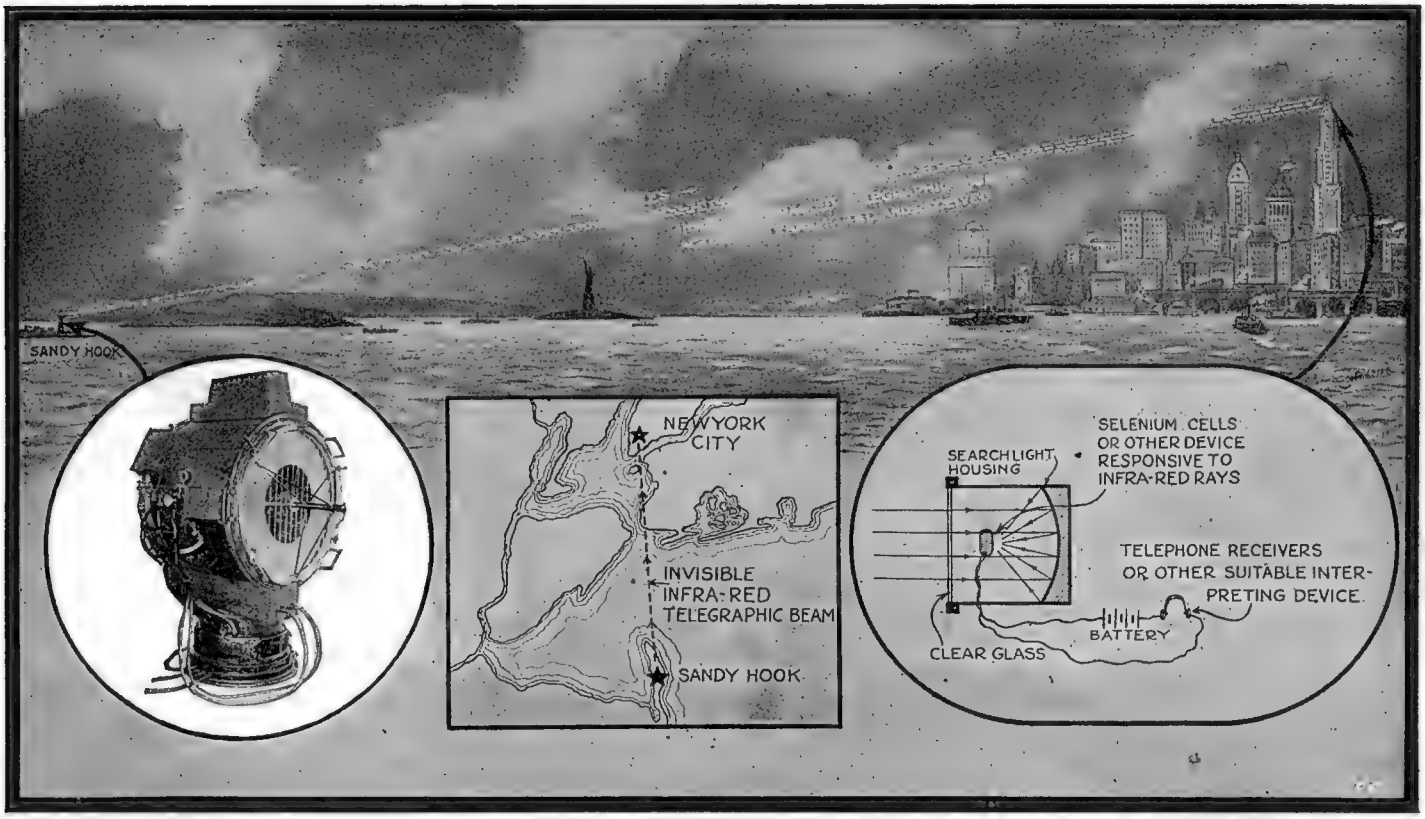
The accompanying photograph shows a new type of electric-driven phonograph designed by Dexter W. Allis, of Whitman, Mass. This invention was the outcome of numerous experiments in an attempt to construct a machine, simple, noiseless, and durable. It will be seen that gears are eliminated; the drive being transmitted from the electric motor at the left by endless belt to the governor and friction rolls. Provision is made for adjusting the belt, for keeping the friction-wheels automatically in contact, and for supplying the bearings with oil from saturated cushions.



This Electrically Driven Phonograph, on Actual Test, Ran Long Enough to Last the Average Man 2,500 Years, at the Rate of One Hour's Run Per Week.

One of these machines was started on a continuous-running test November 16, 1916, and ran continuously for eighteen months. At the end of this time it was operating quietly and perfectly in every way.

During this time the turn-table made over 64,000,000 revolutions, or enough to roll more than around the earth. The electric motor made over 1,475,000,000 revolutions. Allowing that the average phonograph is run one hour per week, this machine, at that rate, would (bar accident) have lasted its owner and his descendants over 2,500 years!



Not One Person In a Million Perhaps, If Indeed That Many, Ever Dreamed That During the War Invisible Searchlight Signals Were Shot Over Their Heads From Sandy Hook to the Tower of the Woolworth Building, New York City, a Distance of 18 Miles. Such Signals Were Actually Sent, However, by Invisible Infra-Red Rays From a Large Searchlight Like That Shown on the Left of the Illustration. A Selenium Cell or Other Suitable Device Indicates the Reception of These Signals.

Telegraphing by Invisible Light Beams

PROBABLY not one person in 1,000,000 residing in or near New York City are or were aware that during the course of the World War the government carried on some very successful and extremely interesting experiments in telegraphing by means of *invisible or non-luminous* searchlight beams—and these were not small searchlights or short-range beams, either!

The accompanying illustration depicts one of the successful experiments conducted by the government experts, in connection with one of the leading American searchlight manufacturers, in which case signals were successfully transmitted from Sandy Hook, 18 miles distant, to a receiving station located atop the Woolworth building tower, in New York City. Not the least sign or flicker of a searchlight beam was visible while this transmission was taking place—a very paradoxical and puzzling phenomena to be sure! And yet the answer is simple when once the principle on which it operates is known.

The answer is, "Infra-red rays." These rays, which are produced in abundance by many sources of light and particularly by high-power arc lamps such as those used in searchlights are invisible to the human eye. Thus, once we have the source of invisible rays, all that we require to transmit signals by telegraphy or otherwise is a sufficiently sensitive instrument which will be affected each time the infra-red rays are thrown on to it. Happily, there are several such instruments known to science.

The infra-red rays which are below the ordinary visible spectrum, as before mentioned, are invisible to the naked eye; they are moreover very penetrating and are subject to the same optical laws as ordinary light. The searchlight or other source of illumination used at the transmitting station is shielded or covered with a deep red glass, containing manganese—as stated by Mr. de Gallaix in his experimental article on this most interesting invention published below—or some other suitable material which will practically eliminate all trace of visible or radiant light, but which will readily pass the infra-red radiations.

Several substances which cut off visible light rays entirely, but which will let the infra-red rays pass almost perfectly, are vulcanite, iodin and bromin.

In the experiments above cited, in which telegraph signals were transmitted between Sandy Hook and the Woolworth tower in New York City, a distance of approximately eighteen miles, a specially treated selenium cell was used at the receiving station. The usual practice in designing a receptor for the infra-red rays is to utilize a housing similar to a searchlight, in one end of which is a parabolic reflector. The incoming infra-red rays pass thru a plain glass window, strike the reflector, which in turn brings them to a focus at a point just in front of the reflector, and at this focal point is mounted a responsive instrument such as a selenium cell, etc.

As Mr. de Gallaix points out, zinc sulfate treated tape may be used or also the Edison tasimeter, which will measure heat accurately down to the 1/10,000 part of one degree, and also the bolometer. If a selenium cell is used, it should be sensitized by the Abney process to render it particularly responsive to infra-red rays. The bolometer is recommended by several experts as probably the best means adapted for such purposes in interpreting telegraph signals, et cetera, where rapid changes in the resistance or other characteristics of the receiving element are necessitated.

The Edison tasimeter and the selenium cell are liable to prove too sluggish if very high speed is required in transmitting the signals. As the diagram shows, a suitable interpreting apparatus such as a loud speaking telephone receiver or a suitable relay and other indicating apparatus is connected with a battery in series with the selenium cell, or bolometer.—*The Editors.*

Invisible Optic Telegraphy by Infra-red Rays

By HENRY de GALLAIX

INVISIBLE optic telegraphy has been the object of long researches on account of the great advantages it possesses over the ordinary optic or radiant light telegraphy. Ordinary optic or light beam telegraphy has the inconvenience of allowing itself to be intercepted with extreme ease by anyone who cares to. As for wireless telegraphy, the use of a secret code is only a semi-efficient remedy. Therefore, the invisible telegraphy by infra-red rays is a remarkable improvement on all systems invented and used before. To solve the problem of invisible optic telegraphy, three methods could be applied.

First: By some sort of mechanical contrivance, make the rays, sent forth by the light source, invisible to human eyes.

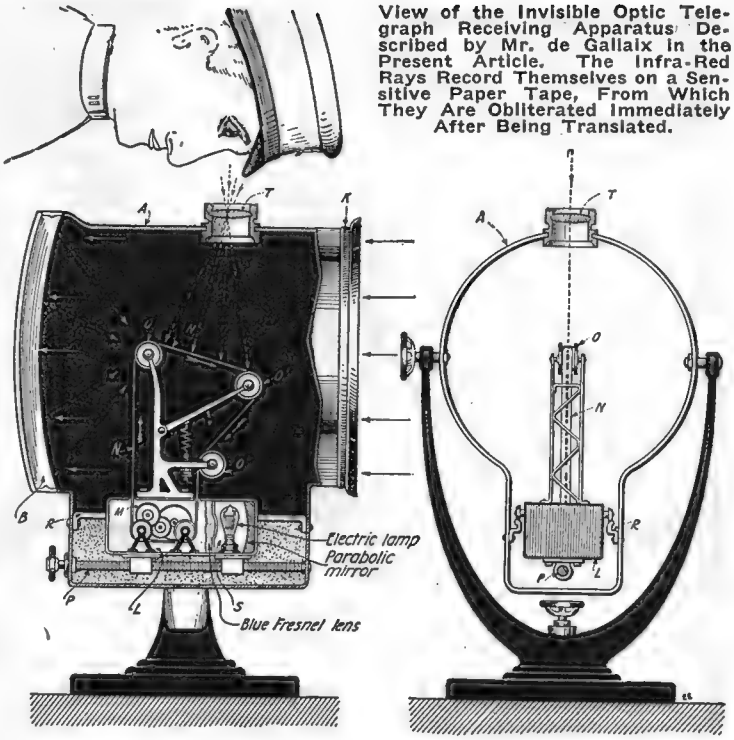
Second: Create a source of rays invisible to one's eye (infra-red rays, for instance) and transmit them directly.

Thirdly: Obtain the invisibility by the physical nature of the rays coming from a light source, visible to one's eye.

Such were the lines on which the question of invisible optic telegraphy had to be studied.

The first method gave no results, attempts were uselessly made to apply to the rays the theories of synchronism, the application of which to the electric current allowed Baudot to create his famous Multiplex telegraph system, which is called after his name.

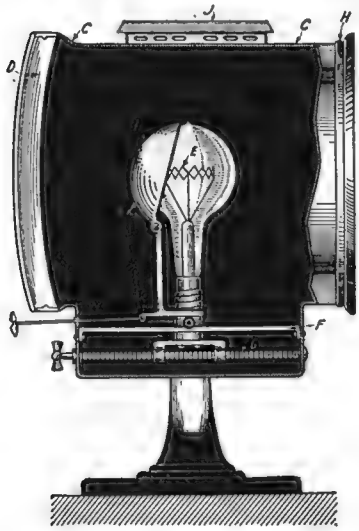
The second method seems at first sight to be the simplest, and it would indeed be the solution giving the best results, if the emission of infra-red rays could be done as that of ultra-violet rays by a Crookes tube, for instance. Pursuing the researches made by Roentgen and Crookes on the extreme rays of the solar spectrum, a number of investigators tried to solve the problem in that way. I have no doubt they will succeed, but up to the present time only the third method has realized the invisible optic transmission. A detailed account of that method makes the subject of the present article.

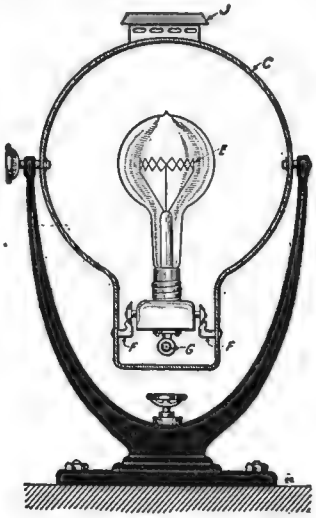


View of the Invisible Optic Telegraph Receiving Apparatus Described by Mr. de Gallaix in the Present Article. The Infra-Red Rays Record Themselves on a Sensitive Paper Tape, From Which They Are Obliterated Immediately After Being Translated.

THE INVISIBLE RAY TRANSMITTER.

The apparatus is composed of a transmitter sending forth the invisible signals, and of a receiver taking in the messages sent forth by the transmitter, which is but a powerful electric incandescent lamp, or else an electric searchlight to which some alterations have been made. If there is a need of transmitting at long distances, powerful searchlights are always used, but I will confine myself to the description of the standard transmitter, which has a diameter of one foot.

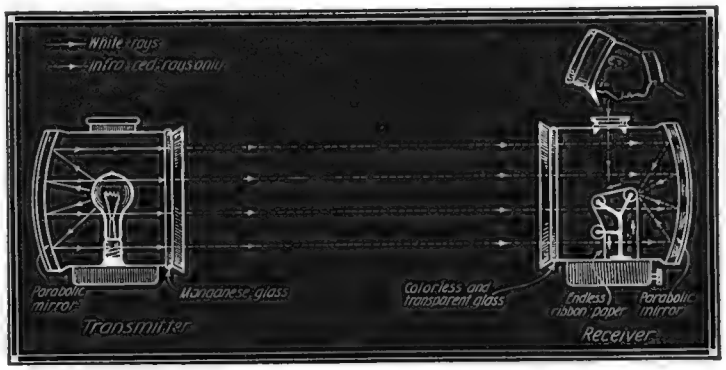




One Form of Infra-red Telegraph Transmitter described by Mr. de Gallaix, Using Instead of an Arc Lamp to Generate the Necessary Rays, a Concentrated Filament Tungsten Lamp. A Red Manganese Glass, or Else Ebonite, Is Used In Front of the Searchlight to Cut Off the Radiant Light Rays.

It is made of a metallic cylinder C, covered inside with black paint, light-tight, tho ventilated by the top and by the bottom J. A parabolic crystal mirror D is placed at one end of the housing. In the center is placed a special electric lamp E with a tungsten filament emitting the least possible blue light and a lighting power of 200 candles. The voltage of this lamp does not matter and is in connection with the voltage at our disposal. The lamp is placed in such a way that its maximum center of light is in the central longitudinal axis of the mirror and a contrivance—slider and dead-end screw F and G permits of moving the lamp forwards and backwards, so as to obtain the proper focus.

The forward end of the housing is closed by a *dark red colored glass*, opaque enough to be penetrated by no other rays than the infra-red ones. So, that looking from the outside the red glass of the transmitter which stops all rays visible to our eyes, the light from the electric lamp cannot be seen; *its unique object is to produce by its white light the infra-red rays, necessary to the invisible transmission.* The opaque, red glass H is a chemical glass in the composition of which enter several metallic salts, especially manganese salts. A hemisphere of blackened metal I, covers half the globe of the electric bulb, being a screen between the light source and the mirror. During transmission the lamp is kept burning steadily, that portion of infra-red rays coming directly from the lamp thru the manganese glass, without the refraction on the mirror being too little for the limited sensitiveness of the receiver. The hemisphere, at rest, between two Morse signals prevents the rays reaching and being reflected by the mirror and thence thru the manganese glass. Either electrically, by means of a Morse key acting on an electro magnet, or more simply by a wire thread, the hemisphere is made to fall down in the bottom of the cylinder, thus unmasking the lamp and allowing the rays to be reflected by the parabolic mirror, and sent back to the manganese glass, which by its composition makes way but to the infra-red rays, invisible to our eye. Such is the way in which luminous signals are sent with the telegraphic code. The transmitter of one foot in diameter, which we have just described, has a transmission power of one-half of a mile. When longer distances are to be covered, large searchlights are used. They have a voltaic arc, a diameter of three to five feet, and a manganese red glass is added either before or behind the *shutter*, according to their construction. The signaling process consists then in opening or shutting more or less quickly the above-mentioned shutter.



This Diagram shows the complete Infra-Red Telegraph System. The Transmitting Lamp on the Left, and the Receiving Instrument Containing a Moving Paper Strip Sensitive to These Rays, On the Right. No radiant Light Rays Are Transmitted or Can Be Seen, Which Would Expose the Position of the Instruments.

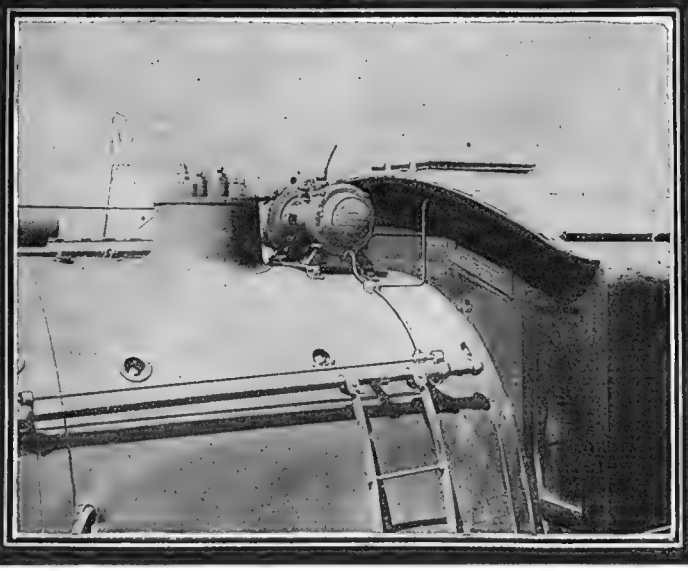
THE INFRA RED RAY "RECEIVER."

The apparatus receiving the infra-red rays sent out by the transmitter, however great the distance may be, has always the same diameter and is, roughly speaking, of the shape and dimensions of the standard transmitting apparatus above described. It is composed of a metallic cylinder A, blackened inside and of a diameter of one foot. As is the case with the transmitter, a parabolic mirror B, of crystal, is placed at one end of the cylinder and at the other end there is a colorless and transparent glass, which has no other object than to close the apparatus and protect the internal mechanism against dust and inclemency. Under the receptor is placed a box of rectangular shape L, containing the mechanism M, destined to give a forward movement to the tape or endless ribbon N, made of special paper on which are to be printed the received telegraphic signals. The mechanism M setting the ribbon in motion is either a clock movement or a very small electric motor. The band of paper passes over a roller O situated exactly at the focus

(*Continued on page* 1214)

If You Have Traveled on Steam Railroads Very Much of Late, You Will Have Taken Note of the Fact That Locomotives Are Now Carrying Extra Powerful Headlights Which Are Capable of Throwing a Strong Beam of Light for a Distance of One-half Mile or More. At First You Would Think It Was Some New-fangled Form of Oil or Gas Light, But When You Come to Investigate, You Will Find That It Is a New Electrical Headlight, Developed in the Past Few Years, Especially for Locomotive Service. These Headlights Provide Approximately 1,000,000 Beam Candlepower.

Over 70,000 of These Steam Turbine Driven Electric Generating Sets for Locomotive Headlights, Have Been Adopted In This Country. One Method of Mounting the Turbine Generator as Well as a Close-up View of the Turbine and the Dynamo, with Its End Housing Open to Expose the Commutator and brushes, Are Shown Below. The Tungsten Filament Lamp Is Rated at 250 Watts and Gives 290 Candle-power. The Voltage of the Dynamo Varies from 32 to 110 Volts in the Different Types. The Dynamo Supplies All Running Lights and Marker Lights.



Locomotives Have Electric Headlights Now

IF you have traveled very much on railroads in the past two or three years, you will have undoubtedly noticed that many of the country's leading railroads are rapidly relegating to the scrap pile the one-time indispensable oil-burning illuminative headlight, and in its place there has come to stay a new electric headlight with its 1,000,000 beam candlepower.

The electric headlight was at first somewhat troublesome, especially in railroad yards, for like many other new appliances it was "too good." That is, it was too powerful and it blinded the enginemen and yardmen. This has been overcome, however, by the use of a special dimmer, and whenever the locomotive is passing thru railroad yards or when passing another train, the dimmer is used and the candlepower of the electric headlight is reduced to approximately that of the oil-burning headlight.

The accompanying illustration shows how the electric headlight equipment is installed on the locomotive as well as the remarkable illumination obtained from its 250 watt—290 candlepower tungsten filament.

To provide for the extra lights about the engine, including the electric light for the firemen, as well as the marker and classification lights on the front of the engine, the steam-driven dynamo mounted on the engine is rated at 500 watts. The engineer also enjoys the electric light nowadays, and by means of the switches and dimmer he can control the lights instantly just as desired.

As the illustrations show, the electric generating equipment is very compact and takes up but slight space on the locomotive. The dynamo is thoroly enclosed to guard against the elements, but is so designed that the electrician can swing open the cover and the brushes and commutator are made instantly accessible for inspection.

The dynamo and small steam turbine are driven and mounted on the same shaft, the turbine taking steam from the locomotive boiler thru an automatic regulator valve which compensates every variation in boiler pressures between 125 and 250 pounds, superheated steam, so as to keep the dynamo revolving at nearly constant speed. The dynamos are supplied in different voltages, from 32 to 110, for the requirements of different railroads. These outfits are very efficient, only sufficient steam to perform the actual work required being admitted to the turbine nozzle. The special rugged tungsten filament in the headlight bulb is enclosed in a nitrogen gas envelope, so as to give the highest efficiency possible.

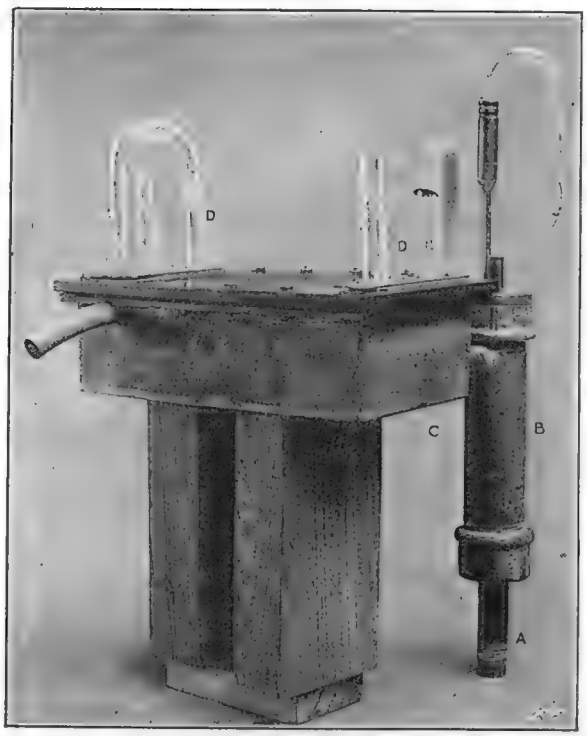
With regard to illumination in general, the 250 watt lamp, properly focust in the standard reflector supplied with the headlamp, under normal conditions, illuminates the track sufficiently for all headlighting purposes for a distance of from 1,000 to 1,500 feet.

For switching illuminative service about yards, et cetera, a 60 or 100 watt lamp in either a 14 or 18-inch reflector gives ample headlighting service. Over 70,000 of these locomotive electric headlights have been put into successful service at the present time.

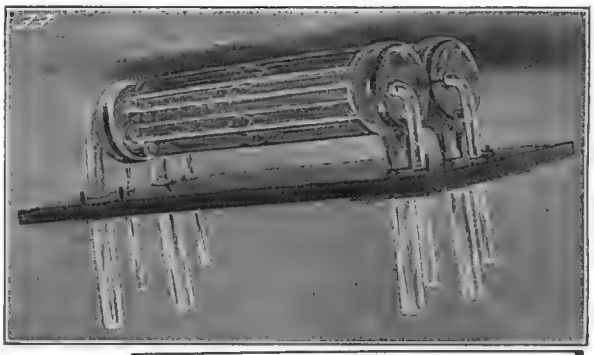
The February and present issues of the ELECTRICAL EXPERIMENTER have been increased by eight pages of pure reading matter. The magazine now consists of 128 pages and contains over 200 illustrations. Perhaps it is superfluous to mention that over ninety per cent. of the text matter is original in all respects. Such matter is not found in other magazines or publications. In this the ELECTRICAL EXPERIMENTER has become a dominant factor in its great field.

Nikola Tesla, the world's greatest inventor, has said many times: "I have never seen a copy of the ELECTRICAL EXPERIMENTER which did not contain something of interest to me."

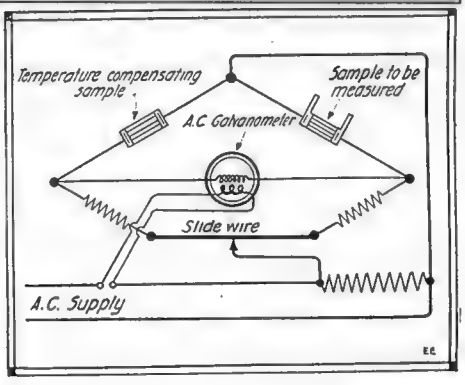
Detecting Icebergs by Measuring Salt in Sea



It Will Probably Come as a Surprise to Many That It Has Now Become Possible to Detect the Presence of Icebergs by Measuring the Amount of Salt in Currents of Sea Water. The Photo on the Left Shows the Apparatus Used for This Purpose. The Sea Water Is Pumped Into "A," Passes a Resistance Thermometer in "B," Into the Bath "C," and from There Into the Electrolytic Cell "D," and Then Out of the Apparatus.



The Photo on the Right Shows a Method of Mounting the Electrolytic Cells Beneath the Lid Which Covers the Bath. Practically All of the Apparatus Is Constructed of Glass, and It Is Really More Sturdy Than It Looks at First Glance.



The Diagram at the Right Shows How the Electrolytic Cells for Containing the Samples of Sea Water Are Placed in Each of Two Arms of a Wheatstone Bridge, Devised for Use with an Alternating Current. An A. C. Galvanometer Is Used. This Apparatus Has Been Developed by the United States Bureau of Standards, and Measures the Electrical Resistance of Ocean Water by the Aid of Alternating Current.

THE saltiness of the ocean varies from point to point, according to circumstances which are of great importance to navigators. The most popular interest in this is probably the fact that the amount of salt in sea water is used to detect and identify ocean currents which determine the paths of icebergs. In the work of the Government in connection with the study of fogs, icebergs, et cetera, it is necessary to obtain accurately the temperature of the ocean, and among other things the amount of salt present in the water. The work has been tremendously expedited by the development of proper instruments.

The determination of the quantity of salt in a given volume of water is now determined very rapidly by a device developed at the Bureau of Standards by Mr. A. L. Thuras and the late Captain Weibel. This apparatus is arranged to measure the salinity (saltiness) of the ocean by measuring the electrical resistance with the aid of an alternating current. By means of providing a sample of a salt water of a known salt content, forming a part of the electrical system, and which is placed in one receptacle immersed in a bath of the sea water similar to that being tested, the effects of temperature are automatically compensated for.

Great speed of operation and accuracy are claimed for this device.

Description of electrical connections: The electrolytic cells for containing the samples of salt water are placed in each of two arms of a Wheatstone bridge devised for use with alternating currents. The alternating current supply passes thru the field coil of the alternating current galvanometer and then thru a non-inductive resistance. The resistance furnishes at its terminals a potential which is in phase with the supply current passing thru the field coils of the galvanometer. From this source of potential is derived the current used for exciting the bridge, by means of the connections as shown.

A Land and Water Speed Demon

By EMERSON EASTERLING

To the rest of the younger generation, Electro-mechanical Bugs, via THE ELECTRICAL EXPERIMENTER:

DEAR SIRS, MESDAMES, ETC.

We all have heard about Silas (or Syrus) Green, the Wright Brothers, who had the *right* idea—Simon Lake, The Ancient Mariner and Bob Fulton—well, here's a new one on us.

Byron Fry, of Vancouver, Washington, is the "guilty guy." He figured out that a "Hod" motorcycle could be dissected, and with the addition of a specially built boat body, a special form of propeller—he says that the propeller has to do with the success of the invention greatly in extent; as you can see, it is peculiar—and by fitting out two out-riggers in the form of air compartments (these are set behind the rear wheels)

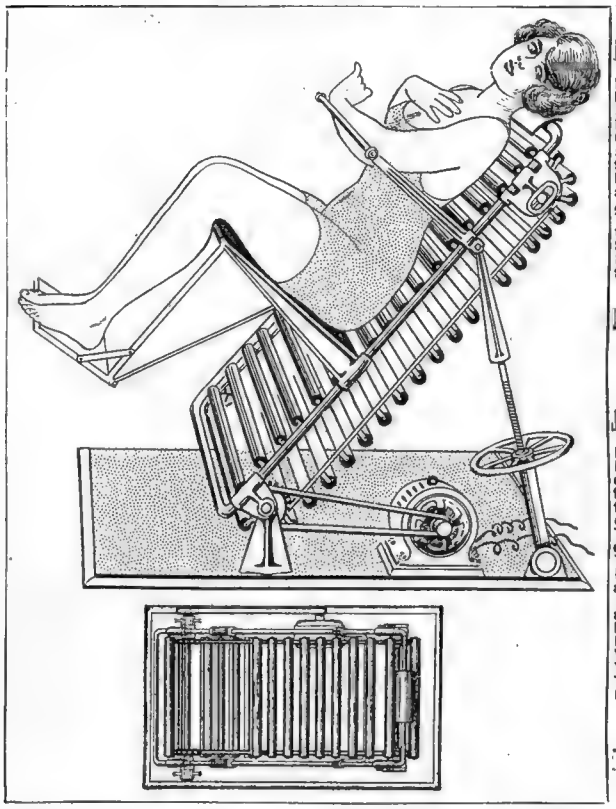
The "Hydro-Terra Firmamobile" Is the Latest Device for Carrying Passengers Over Land and Water Out Vancouver Way. The Motorcycle Engine and Propeller Push the Outfit Over Land To the Tune of 70 Miles an Hour.

and filling the tank with gas and climbing into the machine, that the operator could go to see his "will be" in a truly romantic fashion—like Sir Lochinvar, ford the river, creek or slough, as it may be, not wind around the traffic and follow the trodden paths of commerce and travel.

The writer had the pleasure of riding in the—we will call it a *hydro-terra firmamobile*—from Vancouver over the inter-state bridge and to Columbia Beach on the Columbia River. We sure made time, and he was not letting the—you know what we call it—out. Byron has let her—the hydro, etc.—out to the extent of seventy miles per hour on land. *She* makes twenty-five or six on water. The wheels can be removed for extensive trips

(*Continued on page* 1219)

Electrical Back Massage



Left: Taking an Electric Back Massage in the Electric Roller Chair Devised by a Chicago Inventor, for Giving Body Treatments and Particularly Applications of This Nature to the back, Shoulders and Rear Portions of the Arms of the Patient.

Right: Miss Katherine Nichols, Operator at the Cooper-Carlton Hotel in Chicago Has Invented This New Type of Combination Telephone, Which Has Been Examined by Telephone Experts and Declared To Be a Radical Improvement. As Will Be Seen, You "Hear" Thru Both Ears Instead of Thru Only One.

Photo I.F.S.

THE electrically driven massage machine here illustrated is intended by its inventor, Mr. Glenn S. Noble of Chicago, Ill., for giving body treatments and particularly for giving such treatments to the back, shoulders and rear portions of the arms of the patient.

Among other purposes of this machine, as pointed out by its inventor, are the following: To provide an exceedingly simple and efficient machine for giving a rolling and massaging treatment. To provide means whereby the machine may be readily adjusted for different persons, and may be adapted to regulate the pressure, for the comfort or convenience of the person to be treated.

A small electric motor drives the wooden rollers at a more or less rapid rate, and this produces the desired massage applications to the back muscles of the patient in a manner readily apparent. If it is desired to increase the pressure, this may be done by the person pressing against the cross-bar which is supported in arms extending out from the side brackets on the machine. Likewise, the foot-rest may be moved up more or less in alignment with the seat so that the patient can push against the moving rollers.

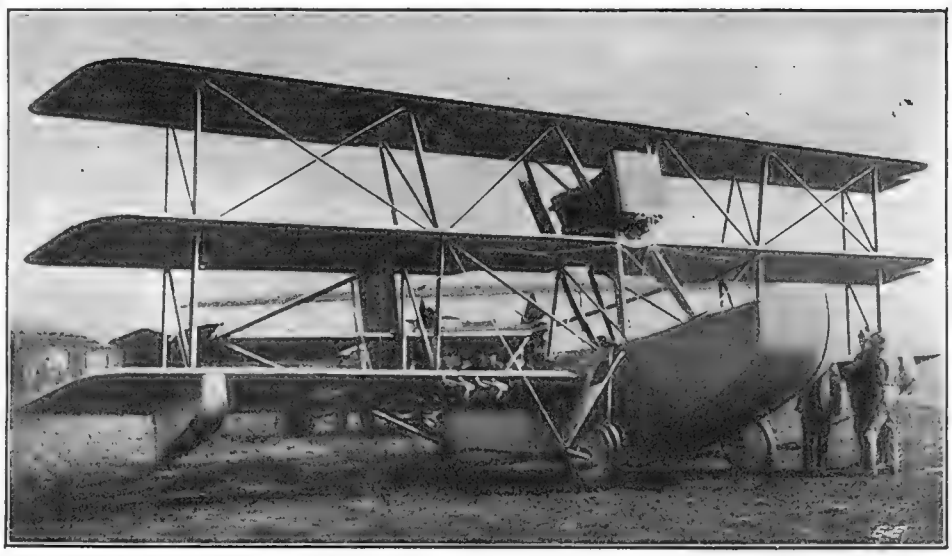
While the chains may be reciprocated or driven in either direction, as the inventor points out, they are preferably driven, so that the engaging rollers will be descending or driven in a downward direction.

Girl Invents New Telephone

MISS KATHERINE NICHOLS, an operator at the Cooper-Carlton Hotel in Chicago, is the inventor of this latest type combination telephone. Experts declare that it will revolutionize the modern type of phone. It has a double receiver device which excludes all outside noises. It can be picked up and talked into as the ordinary desk telephone can. Because of the double type its efficiency in hearing is increased 50 per cent. The European type telephone contains both the receiver and mouth-piece in one combination. This is an improvement over the European phone. Practical demonstrations on wires by telephone experts results in reports that this telephone gives first-class transmission. The phone is perfectly suited to both the automatic and the future wireless phone.

Sperry Seaplane Alights On Sea Or Land

The accompanying illustration shows one of the latest and most important developments in the manufacture of aircraft,—the new Sperry Seaplane,



The New Sperry Seaplane Which Is Adapted To Alight Both on Land and Sea, an Innovation of Great Importance In the Development of the Manufacture of Seaplanes.

which is being tested by the United States Navy Department with a view to its adoption by the Government. The machine is fitted with a collapsible landing gear, designed to permit alighting either on sea or land, a marked innovation of great importance in the development of seaplane manufacture. As will be seen, the new Sperry Seaplane is provided with three wings, making it a triplane, and the fuselage of the body is made in the form of a float or pontoon. In the model shown, a single high powered airplane engine is used to propel the craft. The end carriage and wheels are built extra strong and the outer ends of the lower wings are provided with small pontoons.

"Whispering Ether"

By CHARLES S. WOLFE

I'M not a scientist. "Cans" is my line. Safes, you know, "soup," nitro-glycerine, that kind of thing, get me? "Shoemaker stick to your last." Them is my sentiments, and I stick to my own trade. But now that they got me tied up in this confounded jail, and I ain't got much to do with my spare time I got a notion to jot down what I know about that Proctor affair that you maybe read about in the papers. Reporters was after me thick when it happened, but I was the silent kid. It pays to keep your mouth shut in the circles I move in.

I Point It Right At His Head, and Makin' My Voice As Hard As I Can I Says, Tense-like, "You Speak One Word and You'll Eat Your Breakfast In Hell." And Proctor Smiles. Get That? With My Gat Aimed At His Head He Smiles. And, Fellow, When Proctor Smiles It Gives You the Creeps.

Proctor's in the bug house. Three alienists, or whatever you call those ginks that admit they're sane and prove you're not, pronounced him hopelessly insane. I ain't disputing no jury of my peers. If they say he's a nut, he's a nut, that's all. But——

I didn't get introduced to Proctor in the regular way. We didn't have no mutual acquaintances to slip us the knock-down. It all came about thru me droppin' in one night, casual like, to blow his safe. You might wonder what a yegg would want out of a laboratory safe. Maybe you'll wise up when I tip you it was a contract job. Not on my own, see? I'm namin' no names, but there was a gang of big guys that wanted old Proctor's formula for Chero, and thought it would be cheaper to buy it off of me than him. Anyway, I'm after the paper with the makeup of this explosive when I jimmied the laboratory window.

I'm sayin' this right here: Proctor may be a nut, but he's no boob. I was expecting burglar alarms, scientific thief traps, all that kind of stuff. And I was all fixt for an electrified box. Proctor put one over on me just the same. And if he didn't do it with the mind machine, how in Hell else do you account for it?

I was workin' on the old can. She was a fairly respectable affair, and I make up my mind to blow her. I was drillin' away when click goes a switch and the sudden flare of light dazzled me. Were you ever caught working on a guy's safe, brother? No? Well, take it from Oscar, it's like nothing you ever felt before.

Even before I can see right my mind's workin' overtime hunting for a way out. And then I can see again, and there stands Proctor, a long cord trailin' behind him and 'phones over his ears like the wireless men. And I notice with joy that he ain't got a gat—not that I can see.

Anyway, I risk it. Just as quick as I can draw I flashes my automatic. I point it right at his head, and makin' my voice as hard as I can I says, tense-like, "You speak one word and you'll eat your breakfast in Hell."

And Proctor smiles. Get that? With my gat at his head he smiles. And, fellow, when Proctor smiles it gives you the creeps. And then he says—s' help me—I'm not bullin' you—"Put your gun away, my man, its not loaded."

Can you beat that? It wasn't, either, but how did he know it? Bluffing? That's what I thought, and I sees his bet and raises him. "You move," I growls, "and you'll discover you're a bad guesser."

He smiles again. Say, I can feel my flesh creep yet. "It's not loaded," he says, very calm, and he walks a few steps toward me. I don't shoot. You can't, you know, with an empty gun, and I see that he's called my bluff.

"You win," I says. "It ain't. But I can beat the life out of you with it."

That smile again. His hand goes to his pocket. He pulls out a little bottle, just about the size they sell you pills in. "That, my friend," he says, "is full of Chero. If I just toss it at your feet, you'll never attempt to steal a formula again on this planet."

Does he win? He owns the building. "Call the officer," and I chucks the gun on the floor. "I'll go quietly."

"Sensible," he remarks; "very sensible. You possess judgment, even if you do lack courage. Who sent you here?"

"Call in the bulls," I growls. "I'm not squealing."

He takes no notice. "I know who sent you. I knew you were coming."

"Look here," I blurts, "if that gang framed me, I'll talk. They sent for me, I didn't go to them. I——"

"No one informed me, if that's what you mean," he says, coldly. "It is not necessary for any one to inform me of anything. The world is as an open book to me."

(That's just what he told that gang of saw-bones afterwards, and they said he was looney. But if they had seen him as I seen him ———)

(*Continued on page* 1208)

Thomas A. Edison 73 Years Old

HAVING been a telegraph operator in his youth, Thomas A. Edison, America's grand "young" man of science, knows that "73" is the code number for "all good wishes." On February 11th, which marked his seventy-third birthday, messages from all parts of the country arrived at the Edison laboratory in West Orange, expressing sentiments identical but less laconic than dash-dash-dot-dot, dot-dot-dot-dash-dot.

A little thing like a seventy-third birthday didn't keep the "Old Man" from getting up at 6 o'clock in the morning and, without thought of shaving, hastening down the hill to his laboratory to spend five hours intent upon a chemical and metallurgical problem that needed solving. Thomas Alva Edison's former associates, gray-haired men, now successful engineers and inventors themselves, who worked with him day and night in those lean days back in the late seventies and early eighties at Menlo Park, when no one knew where next week's payroll was coming from, waited patiently and let the "Old Man" putter around his laboratory at West Orange until noon, when they kidnapped him to make sure he would not forget his own birthday party.

The accompanying illustration shows an excellent marble bust of Edison, by Onorio Ruotolo, the Italian-American sculptor of New York City. This crystallizes in marble the spirit and energy of Thomas Alva Edison.

Ruotolo recently completed this study which he calls "The Brother of Prometheus." He is the sculptor whose recent "Red Cross group" and "Prince of Sorrows" bust of Cardinal Mercier brought him international fame.

Remarkable Marble Bust of Thomas A. Edison Just Completed by Onorio Ruotolo, the Italian-American Sculptor of New York City. It Characterizes Wonderfully the Spirit and Energy of the Great Inventor.

It wouldn't be Edison's birthday if he didn't spend a few hours at work and then go to the laboratory library to be surrounded by a dozen reporters who shouted questions in his ear ranging from prohibition and the Irish question to communication with Mars and Sir Oliver Lodge's spirits. He had some difficulty hearing the questions, but once he understood them his clear, blue eyes fairly snapt and he shot his answers back without hesitation.

"We don't need that stuff," he said of liquor. "The Irish mind is very complex," and he dismissed Home Rule. As to reaching Mars by wireless, he said: "It may be done, but how are we going to know whether a man or a chimpanzee receives our message?" And all he had to say as to the existence of spirits and making them talk was "fifty-fifty."

[Editor's Note.—In a later interview, however, Mr. Edison stated that he believed it possible and evident that powerful radio signals radiated from the earth pass out into interstellar space and reach the distant planets, the signals being carried by the etheric waves.]

"I expect to do as much work when I'm eighty-five as today. It will all depend upon the condition of the container," and he tapt his chest.

"Men are more efficient than they were fifty years ago. We have more machinery now and some day all our work will be done by machinery. Then we'll be more efficient still. The men will be paid high wages and will simply direct the machines. We'll even have automatic machinery make the machines. We're working on some of those things here now.

"No, I don't believe in a six-hour day if a man is interested in his work. If a man is interested in what he's doing, he won't keep his eye on the clock, but he'll see the thing thru. Hard work won't hurt anybody who likes it.

"A man to be efficient must take care of what he eats. Americans eat too much, anyway. Anybody who is clogged with food and gives his stomach too much work can't do good work himself."

"What do you think is your greatest invention?" he was asked.

"The phonograph or moving pictures—I don't know which."

At noon the employes of the West Orange Edison plants, led by their band, marched past Mr. Edison and pelted him with flowers. Then the Edison Pioneers, men who were associated with the inventor at Menlo Park before 1885, took Mr. and Mrs. Edison and members of their family to luncheon in one of the Edison work's buildings.

President Wilson wrote the following to T. Comerford Martin, Vice-President of the Edison Pioneers:

"I canont deny myself the pleasure of sending a message to be read at the celebration of Mr. Edison's seventy-third birthday. I am proud to count myself among the friends and admirers of Mr. Edison, and I beg that you will convey to him my warmest congratulations and my hope that he will see many very happy returns of the anniversary, marked by an increasing number of scientific triumphs."

New Inventors' Society Formed

The *National Laboratory Foundation* was organized at a convention of inventors held recently in New York for the purpose of developing American inventive genius. It is the purpose of the founders to establish a laboratory wherein promising inventions can be experimentally developed, protected and then marketed.

At the sessions held the frame-work of the foundation was laid, and the board of governors who will direct its development elected. Immediately after the election the board adopted the following resolution announcing the purposes of the organization:

"To secure and establish the ultimate right of the public to its heritage of intellectual property. Therefore, be it resolved, The object of the National Laboratory Foundation is to assist in the just and proper development of American inventions and industry by selecting, developing, testing and advancing the use of meritorious inventions to benefit the public, the inventor and the manufacturer and safeguard the interests of all."

The board of governors includes the following: Thomas Howard, executive chairman, an automobile and motion picture engineer; Professor W. H. Burr, former member of the Isthmian Canal Commission; Professor Charles F. Chandler, Columbia University; Dr. Charles P. Steinmetz, General Electric Company; Simon Lake, submarine inventor; John Hays Hammond, Jr., and Dr. Lee de Forest, wireless inventor.

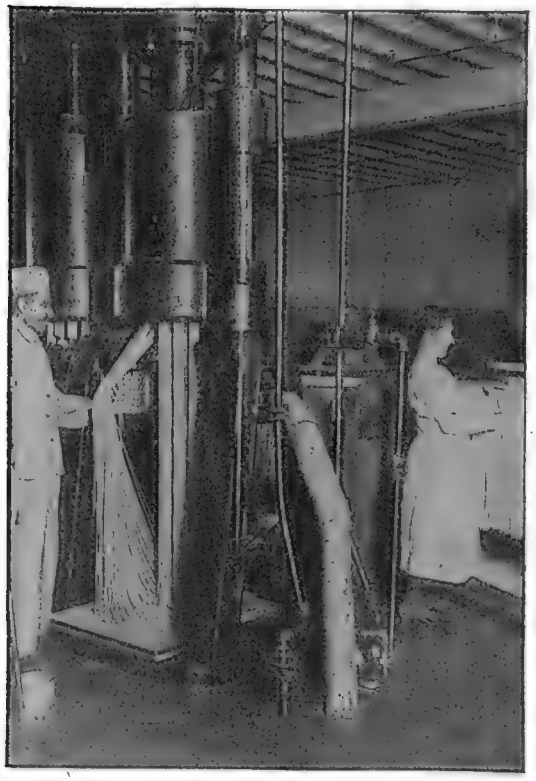
During a banquet held at the Hotel Astor, Simon Lake delivered a speech outlining the progress of invention from the earliest historical period, in which he said:

"The pirating of American inventions and designs as practised by certain countries for years is also something for the serious consideration of this convention, and American manufacturers should not enter into a league of nations treaty without a clause affording protection to American creative thought and inventions equal to that which we afford foreigners."

Major William J. Hammer, U. S. A., who had charge of all ideas submitted to the government during the war said that out of the vast number that poured into his department only 150 inventions were found sufficiently practical to warrant further consideration. He said the foundation could well carry on this work of selection and assistance in peace time.

Macaroni 'A L'Electricité

AN interesting example of the engineering service which a central station can render an industrial plant is that of a large macaroni plant at Libertyville, Illinois. When this plant was acquired, the electrical service company had the opportunity to make a study of the possibilities, and as a result a complete *electric drive* was installed, nearly all the apparatus being individually driven by motors.



The process of making *macaroni* and other alimentary pastes is essentially one of *manufacturing* rather than *baking*. Flour is received in barrels and taken up a motor-driven conveyor to the sifting and storage rooms. Hence, it is run thru chutes in appropriate quantities to the mixers on the floor below. Each mixer has two curved knives which, revolving, cut and fold the flour as water is added by the operator. When finished, the dough is dumped into the pan of the kneading machine. As this pan turns under large toothed wheels, the dough is kneaded until all lumps have been broken up and the mass is of uniform consistency. The two newer units have 15 horsepower, squirrel cage, a.c. motors for the mixers and similar 10 horsepower motors for the kneading machines.

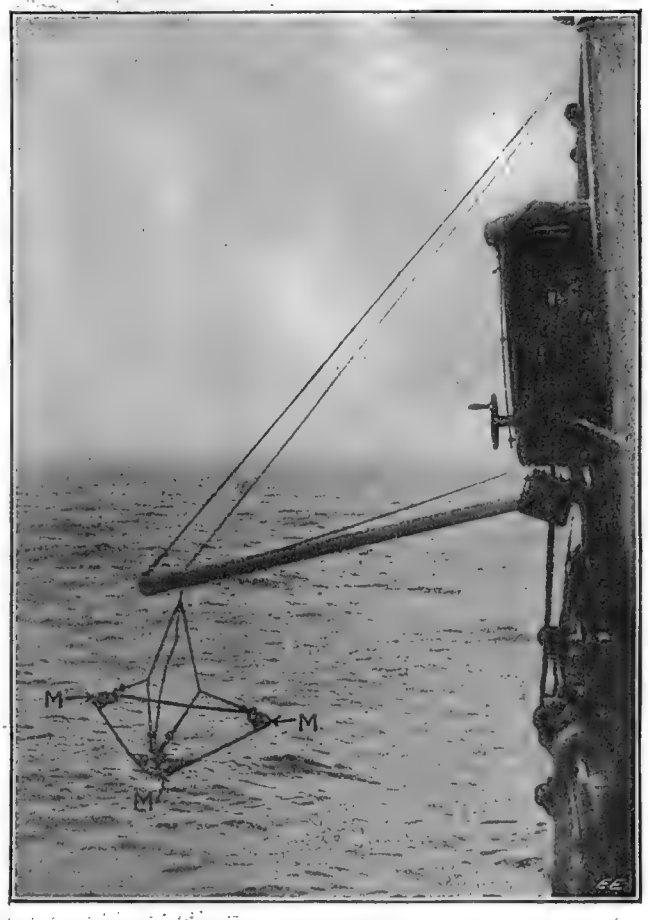
Left: — Macaroni and Spaghetti by the Yard Being Made by Electrically Operated Machinery. Dies Form the Holes.

After kneading, the dough is cut into blocks and taken to the presses. Each of these has two cylinders, one to be charged while the other one is under the press. In the bottom of each cylinder is a die-plate with appropriate holes, thru which the dough is forced under a pressure of 3,400 pounds per square inch. See photograph here reproduced. Oil under pressure is used in the press cylinders; it is actuated by a battery of heavy-duty pumps driven by a 30 horsepower electric motor.

As the long strings of dough come out of the orifices, they are cut off and hung on wheeled racks, which are run into drying chambers. The drying operation is one requiring very close control of the humidity of the air; it is secured by passing the air thru a carrier air conditioner. *Photo Courtesy Westinghouse E. & M. Co.*

U. S. Submarine Detector

The accompanying photo shows a newly invented sound detector for discovering the nearby presence of submarines, which is being used by United States Navy destroyers. The device is a delicately sensitized apparatus, one part of which is drawn along beneath the surface of the water. The presence of any ship in the vicinity, and especially submarines, is instantly detected by this instrument. The device comprises three microphones mounted at the three corners of the triangular frame-work. These pick up the sounds of the submarine's propellers. Many a U-boat met its Waterloo on account of this ingenious detector devised by Uncle Sam's electrical experts.

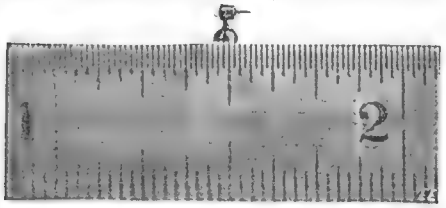


Right:—Here's the Submarine Sound Detector Used by Uncle Sam During the War. The Microphones Were Submerged When Listening for the U-boats's Propellers. Photo (c) by I. F. S.

World's Tiniest "Turbine"

Herewith is a photo of a turbine I have just completed, that, so far as I have been able to ascertain, is the smallest that has yet been built. Your readers may remember that I built the smallest working electric motor and the smallest steam engine in the world; these were on exhibition at the P. P. I. E., San Francisco, also at the University of North Dakota.

The turbine I have just completed is several times smaller than any of these. The



rotor or revolving part is made of steel and has six slots or pockets; the diameter of rotor is .032 inch, the shaft is .007 inch diameter, the weight of rotor and shaft is 2 milligrams. The diameter of complete turbine is .048 inch, or about *half the diameter of an ordinary pin head.* It weighs complete 12 milligrams.

The turbine will not run with steam, as that is too heavy for it; it is mounted on a hollow pedestal so an air hose can be attached at the bottom, and runs at a very high speed when comprest air is applied.

Photo at Left Shows the World's Tiniest Turbine. It Operates on Comprest Air and Is Made of Gold. It Compares Favorably with a Pin-head.

The casing of the turbine is made of gold. The complete machine is built up of eight parts. The tiny turbine is kept in a glass covered case so that no moisture can get to it, as this will affect the running qualities.

IVAN T. MEDLAND.

Novel Perfume Vaporizer

Many perfumes which have an alcoholic base and many antiseptic solutions such as for instance those containing eucalyptol, menthol, etc. can easily be vaporized between 40° and 60° Centigrade. The new French perfume diffuser shown in our illustration heats the solution by means of an electrical current using nothing but an ordinary carbon lamp to supply the heat. These French perfume diffusers are made very artistically in the form of urns or otherwise of art glass or transparent porcelain thru which the light shines.

At the Right is Seen the Latest Electric Vaporizer From France. The Lamp Also Lights Up the Transparent Container.

The Positions of Atoms in Metals

By Dr. A. W. HULL, Ph.D.

When a narrow beam of X-rays passes thru a fine powder of any crystalline material, it produces on a photographic plate placed just behind the powder a pattern of concentric circles. These circles are produced by the reflection of the X-rays from the planes of atoms in the crystal, and their diameters are a measure of the distances between these planes of atoms. By measuring the diameters of the circles the exact positions of the atoms can be determined.

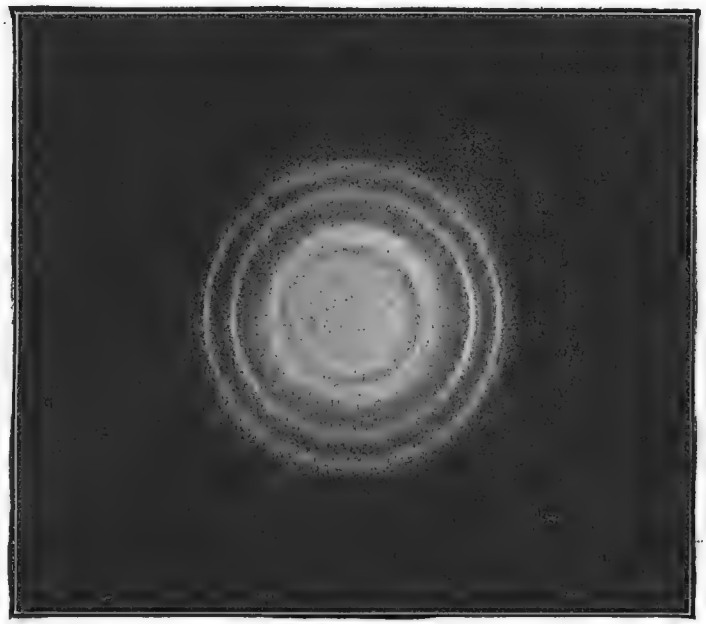


Fig. 3 Shows the Typical Effect of Aluminum Filings Taken by the Aid of the X-Ray Tube and Diafram, Illustrated at Fig. 2. The Distance Between the Lines or Circles on the Photo Enable the Scientist to Compute the Distance Between the Planes of Atoms In Various Materials.

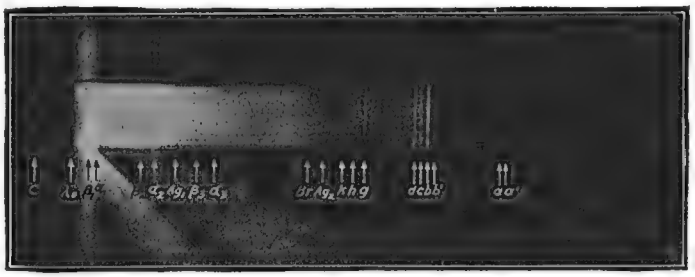
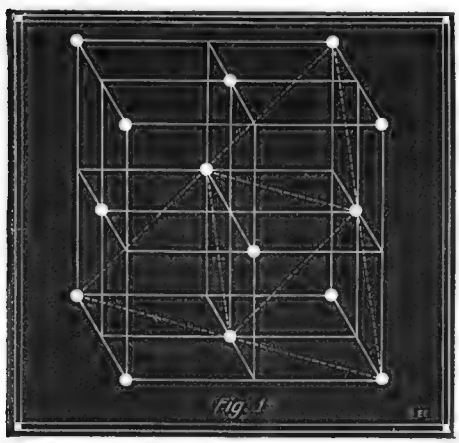


Fig. 4 Shows An X-Ray Spectrum Obtained From Tungsten.

THE determination of the exact positions of atoms in solid bodies is the next to last of a series of discoveries that have made atoms as real as the bricks of which houses are built. The atom of twenty years ago was the "hypothetical smallest subdivision of matter." The atom of today is a real object of definite shape and size. We know what it is made of. We know its weight in grams. We can see its splash when it impinges on a plate of fluorescent material. We know its exact speed when it flies about as gas. And, lastly, we know its exact position when it forms part of a solid body. So spoke the author of this extremely interesting paper recently presented before a joint meeting of the American Institute of Electrical Engineers and the American Physical Society.

First came the discovery of *dancing molecules.* Heat had been considered a substance. The "Kinetic Theory of Gases" proved that it is a condition, *viz.,* the motion of the molecules, which fly about like frenzied bees, bumping against each other and the walls of their enclosure. Thru this discovery all the store of facts and laws about gases can be correlated by the single picture of these dancing molecules. We believe in these dancing molecules as firmly as in the law of gravitation. Whenever we think of gas we see *dancing molecules!*



The Most Common Arrangement of the Atoms In Metals Is That Corresponding To the Face-Centered Cubic Scheme, Shown at Fig. 1, Above. This Is Also the Most Important, Since Most of the Useful Metals Have This Arrangement of Atoms.

The next discovery was J. J. Thomson's *streaming electrons.* Our text-books taught, and some still do, that electricity is not a fluid, tho it behaves in many ways like one. Thomson proved that electricity is a fluid, that its atoms are the electrons which constitute the atoms of matter, and that it flows thru wires just as water flows thru pipes.

Next came the *weighing of the atoms.* Faraday showed long ago how to determine the weight of an atom in terms of the charge it carries in electrolysis. There remained, therefore, only the measurement of this "unit charge," *viz.,* the charge of a single electron, by Millikan, to give the exact weight in grams of any atom that can be deposited electrolytically. As soon as the weight of any one atom is known, the weights of all the others can at once be calculated from the known relative atomic weights.

Then came the *counting of individual atoms.* This began with Sir William Crookes' "spinthariscope," and culminated in the beautiful experiments of Rutherford and Geiger, in which they counted one by one the helium atoms (the so-called "α particles") as they emerged from the surface of disintegrating radium; and then allowed them to pass, one by one, into a thin-walled glass tube, until enough had accumulated to form a gas whose pressure could be measured and spectrum analyzed.

These counting experiments led directly to the determination of the *composition of the atom.* J. J. Thomson had proved that every atom contains electrons. Rutherford proved that it also contains a positively charged kernel or *nucleus,* very small compared to the whole atom, but so dense that it contributes nearly the whole weight of the atom. The hypothetical atom thus became a concrete thing that can be visualized; a tiny (but large enough to be studied) solar system, with *nucleus sun* and *electron planets. The only respect in which one kind of atom differs from another is the magnitude of the positive charge of the nucleus, which determines how many electrons it can hold in its planetary system, and hence all its physical and chemical properties.*

Finally came the discovery, by the Braggs, of the method of determining the *positions of the atoms in solid bodies.* The beautiful "point lattices" of the crystallographers were hypothetical. They enumerated possibilities but could not point out the reality. The Bragg measurements of atomic distances give the actual arrangements. They are as accurate and reliable as those of the surveyor or astronomer. The only assumption made is that the arrangement of atoms is a regular one which repeats itself, and this assumption can be checked by experiment. The method consists simply in the measurement, by means of a special "measuring rod" which will be described, of the distance between atoms in three or more different directions. From these measurements a model can be constructed, which can then be checked by further measurements. The model must also agree with known physical properties of the substance, such as density, atomic weight, and crystal habit. A model which contains but one kind of atoms and satisfies all these tests may be regarded as very reliable. The reliability is still further increased by the fact that all the models investigated thus far have turned out to be very simple. In cases where there is more than one kind of atom, *i. e.,*

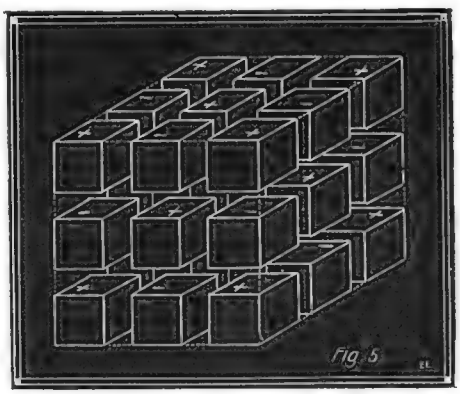


Fig. 5 Shows the Arrangement of Atoms In a Magnetic Structure Such As That Found In Iron.

compounds or alloys, an additional factor, *viz.,* the size and shape of the atoms, must be taken account of. There is one type of

(*Continued on page* 1193)

. . . AUTOMOBILE NEWS . . .

Here Is the Newest Way of Identifying the Car—the Electrical Way. Electric Lights Shine Through Stenciled Initials In This Little Metal Device. Two Small Red Lenses Are at Either End of the Device Which Serve as a Standing Lamp for the Car. (On Use on New Flat Car)

FORD MAGNETO TESTER.

With this device you can test Ford magnetos without removing them from the engine. You can check them exactly and ascertain whether or not there is anything wrong.

The principle of its operation is a neat little problem in the phenomenon of alternating current. The voltage supplied by the Ford magneto is alternating and increases directly as the speed of the engine increases. Now if a resistance and ammeter are connected in series across the magneto terminal, the current which would flow would vary directly with the speed and unless the speed of the engine can be accurately determined, this method could not be used to determine the strength of the magneto. Now if a reactance coil be used in place of the above resistance, the ammeter will indicate a constant current at all engine speeds. The strength of the current depends directly upon the strength of the magneto. The reason that a reactance coil in series with an ammeter will give constant current is due to the fact that as the engine speed increases, both the voltage and the frequency of the magneto increase directly. But the opposition of the reactance coil also varies directly as the frequency. But as the current which flows depends on both the voltage and on the opposition of the reactance coil, which increase and decrease at the same rate with the speed of the engine, therefore, the current which flows is independent of the engine speed.

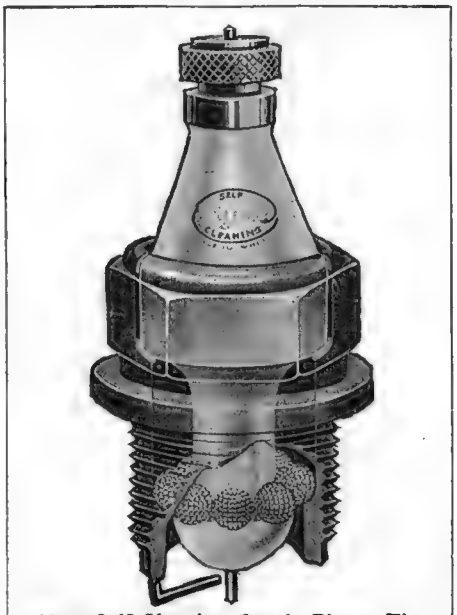
The Magneto Tester here shown is built on the above principle and consists of a properly designed reactance coil and an alternating current ammeter, mounted in a neat wooden case. The scale is calibrated to show the proper strength of the 1915 and later Ford magnetos, also 1914 and earlier Ford magnetos.

Useful Ford Magneto Tester.

A SELF CLEANING SPARK PLUG.

Anyone who has had anything to do with spark plugs knows that most trouble is caused by short-circuits on the inside of the plug. The accompanying sectional view of a new self-cleaning spark plug invented will show how the cleaning is accomplisht. The plug is made with a special size inner chamber, in which a number of little porcelain balls are placed. With each impulse of the engine, either compression or explosion, these little balls are forced up and down in the inner chamber with the result that their rough surface completely cuts away the soot, oil and carbon and keeps the insulator and inside walls entirely clean of any deposit. This, of course, insures a perfectly operating spark plug so long as the necessary charge of current comes from magneto or battery in the usual way.

The practicability and efficiency of this self-cleaning spark plug has been fully proven by many thoro tests it is claimed. One of these plugs was in constant use on a car for 78,000 miles—more than 3 times the distance around the world—and the plug worked perfectly all that time. Not once was it necessary to remove it for repairs or cleaning. Other tests have been made on passenger cars, service cars, heavy service trucks, and even on cement mixer engines, all with the same perfect results. One test was made on a truck on which it had previously been necessary to change spark plugs every day for cleaning. One of these self-cleaning spark plugs was installed and has now been in use four months without need of change for cleaning or repair.

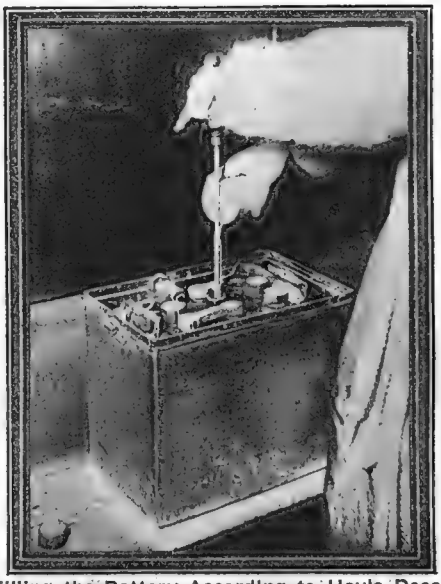


New Self-Cleaning Spark Plug. The Porcelain Balls Are Constantly Moving and Thus Keep the Plug Clean.

THE STEINMETZ ELECTRIC VEHICLE.

Dr. Steinmetz's latest accomplishment has startled the automotive industry. In a word, he has produced: An electric vehicle that requires 30 per cent. less battery than any other of like capacity, is manufactured for one-third less, is 25 per cent. lighter in weight, runs 45 miles on one charge, costs but 35 cents a day to operate and recharges its own battery on down grades.

After 15 years of experimentation, Dr. Steinmetz has perfected an industrial truck and a delivery car with these long-sought advantages



Filling the Battery According to Hoyle Does Not Need an Expensive Equipment. Water May Be Put Into the Battery Safely Without Spilling Over the Cells by Pouring Water From a Glass or Cup Down a Screw Driver, Whose Tip Is Placed In the Cell to Be Filled.

GEAR SHIFTING DONE AWAY WITH.

A recent device exhibited at the automobile show in New York City was a clever turbine drive affair which threatens to revolutionize the automobile industry.

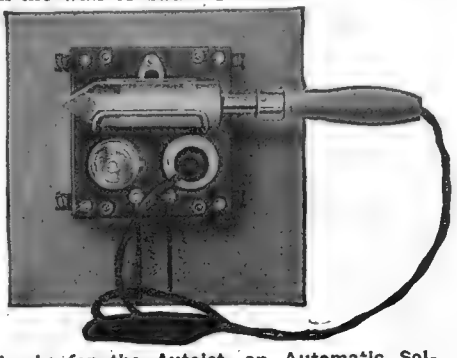
With this new transmission, the power is communicated to the driving axle, by means of a turbine which pumps a liquid to a hydraulic motor, the liquid being returned to the turbine chamber and pumped over and over again.

AUTOMATIC SOLDERING IRON RACK.

It consists of a small slate panel arranged for wall mounting and carrying a support for the iron which acts on the principle of the telephone receiver hook. When the iron rests on the cradle or hook the weight bears it down, and resistance which is mounted on the back is cut into circuit with the iron. The current is reduced and the temperature held at a safe value, but ready for service just as soon as the iron is lifted from the hook. This operation automatically disconnects the resistance from the soldering iron circuit and allows full current to again be applied to the heater coil in the iron until the iron is again placed in the cradle hook.

Below, on the same panel, there is a push-button snap switch and a standard receptacle, to which the plug of soldering iron cord is connected.

This automatic rack, therefore, is a complete switchboard which may be mounted on the wall or back of bench.



Handy for the Autoist—an Automatic Soldering Iron Rack.

Popular Astronomy

By ISABEL M. LEWIS, M.A.
Of the U. S. Naval Observatory

Astronomy in Our Everyday Life

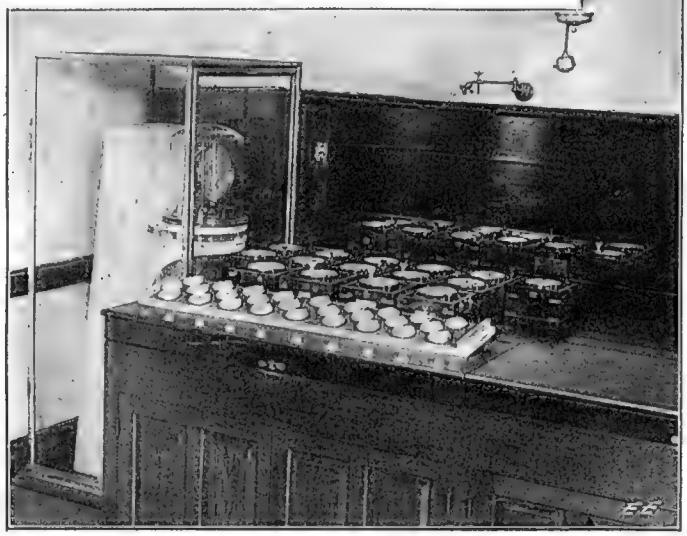
THE opinion is quite generally held that astronomy is an abstract and theoretical science far removed from practical everyday affairs.

Yet a knowledge of astronomy is absolutely essential in navigation, exploration and surveying. Even in our civil life the settlement of some legal questions may hinge upon the knowledge of an astronomical happening and in the regulation of our clocks astronomy touches the daily life of everyone, for it is from observations of the stars *alone* that our time is determined.

The rotation of the earth upon its axis is the nearest approach to invariable motion known, and is for that reason employed as the basis for all determinations of time.

As a result of the earth's daily rotation upon its axis from *west* to *east* there is an *apparent* daily rotation of the heavens from *east* to *west*, and so we speak of the sun, moon, stars and planets "transiting" the meridian when it is really the meridian that is passing by these objects in the opposite direction.

U. S. Naval Observatory, Washington D. C. Main Building from Which Time Signals Are Sent Forth to All Points East of the Rockies.



Torpedo Boat Watches and Ships' Chronometers Sent to the U. S. Naval Observatory To Be Tested and Rated. The Clock Mounted on a Stone Pier in the Glass Case to the Left Is a Standard Mean Time Riefler Clock.

The interval between two successive "transits" of the same star, or of some fixt point over the same meridian is called a *sidereal day*, and it is the fundamental unit in measuring time. This sidereal day is divided into twenty-four sidereal hours and there are clocks known as sidereal clocks which keep sidereal time. The driving clocks of equatorial telescopes are always sidereal clocks. By means of such a clock it is possible to impart to a telescope a motion equal to that of the earth on its axis and in the opposite direction, thus nullifying the effect of the earth's diurnal motion and keeping the object observed always immovable in the field.

The zero point for the sidereal day is the vernal equinox or the point in the heavens where the ecliptic and the celestial equator intersect. When the vernal equinox is on the meridian it is sidereal noon, and when it has moved one hour past the meridian it is *one hour*, sidereal time. The angular distance of the vernal equinox from the meridian measured along the celestial equator toward the west thru 360°, or, when exprest in time, thru 24 hours, is called the "Hour Angle" of the vernal equinox and it gives the sidereal time at any moment. (See Fig. 1.)

It is not practicable to run our clocks on sidereal time for the reason that sidereal noon falls at all hours of the day and night in the course of a year, and we prefer to have our noon agree as closely as possible with the true *solar noon* which occurs when *the sun is on the meridian.* To run our clocks by true solar time is impossible, for the interval between successive transits of the *true* sun over the meridian is not invariable in length. This is due partly to the fact that the motion of the earth in its orbit is not uniform and partly to the fact that the earth's path around the sun is inclined to the equator along which the time intervals are measured. The range of the variation in the length of the true solar day in the course of a year from these combined causes is over half an hour. No clock could be regulated, therefore, to keep this true solar time, *or sun-dial time*, as we may call it, since it is the kind of time indicated by a sun-dial.

To obviate the difficulties presented, both by sidereal and true solar time, recourse has been had to a *fictitious* body known as the *mean sun.* This body is assumed to travel at a uniform rate in the celestial equator, instead of in the ecliptic, completing a circuit of the heavens in the same time as the true sun. Since its motion is uniform we can regulate our clocks by it. A mean solar day is the interval between two suc-

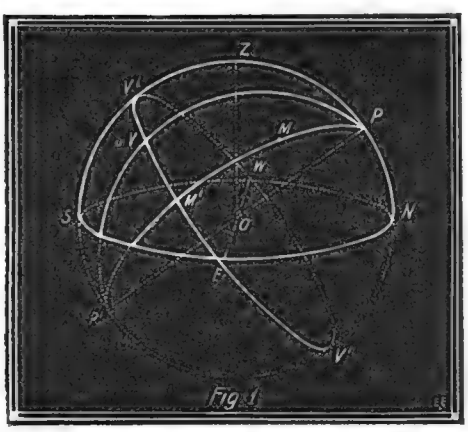
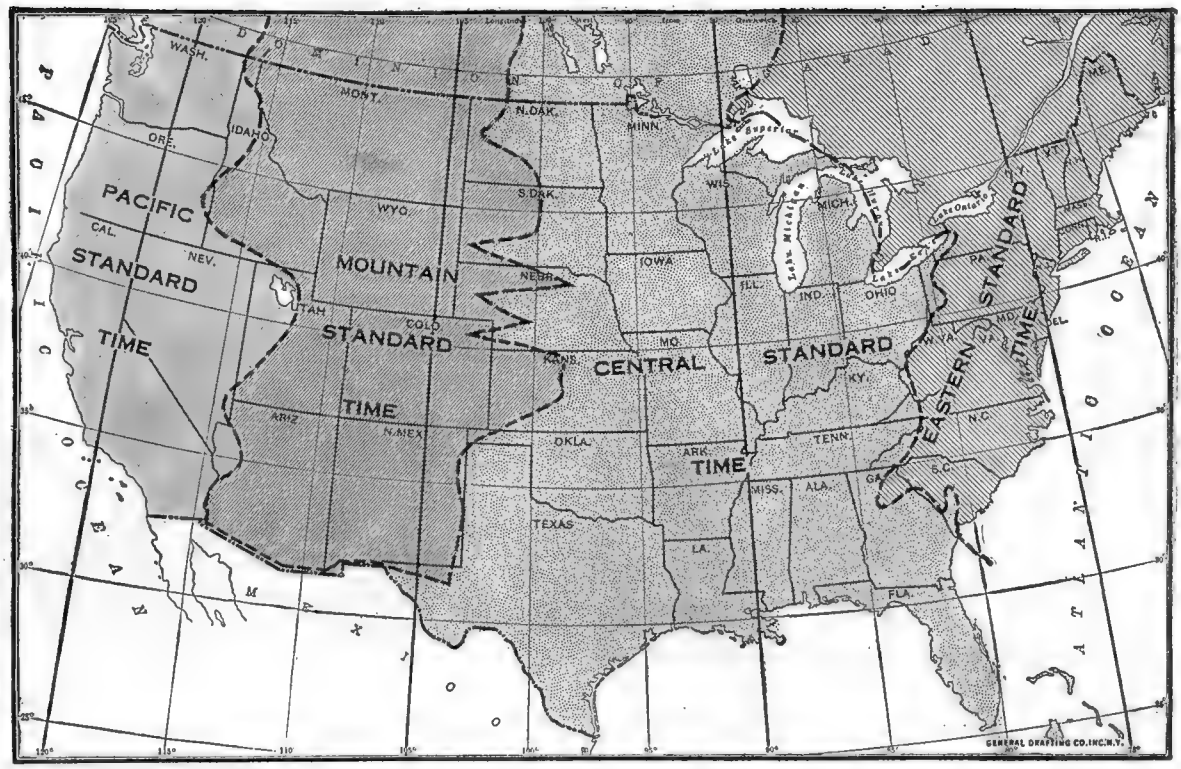


Fig. 1

The Earth, at O, Is Assumed To Be at the Center of a Sphere of Infinite Radius Called the Celestial Sphere. The Plan of the Horizon of the Point of Observation Intersects This Celestial Sphere In SWNE (the Four Points of the Compass) and the Earth's Polar Axis Produced Intersects the Celestial Sphere in P and P', the North and South Poles of the Heavens Respectively. The Celestial Equator EV'WV" Is the Intersection of the Plane of the Earth's Equator With the Celestial Sphere and the Planes of the Terrestrial Meridians Intersect the Celestial Sphere in Celestial Meridians or Hour Circles, see PVP' and PMP'. The Hour Circle That Passes Thru the North and South Poles of the Heavens and the Zenith Is the Meridian of the Place of Observation (NPZS). The Direction of the APPARENT Daily Rotation of the Celestial Sphere Is East to West In the Direction EV'W. The "Hour Angle" of Any Point in the Heavens Is the Distance of Its Hour Circle East or West of Meridians, Exprest In Time Usually, Just as the Longitude of a Point on the Earth's Surface Is Its Distance East or West of the Zero Meridian (Greenwich) and May be Exprest In Time Also (as a Place 75° West of Greenwich Is FIVE HOURS West of Greenwich. Now the SIDEREAL TIME at Any Instant Is the Hour Angle of the Vernal Equinox V, Which Is the Point Where the Ecliptic or Apparent Path of the Sun Thru the Heavens Intersects the Celestial Equator. This Sidereal Time Is Measured from the Meridian Westward Thru Twenty-four Hours Along the Celestial Equator. (In the Fig. V'WV"V Is the Arc Expressing the Sidereal Time.) V Makes One Complete Revolution in Twenty-four Sidereal Hours. The Mean Sun Is also Assumed to Move at a Uniform Rate In the Celestial Equator EV'WV", and Its Hour Angle at Any Instant Gives the Mean Solar Time.



The Accompanying Map Shows the Four Standard Time Belts Into Which the United States Has Been Divided (as Readjusted by the Interstate Commerce Commission and Made Legal by Act of Congress, Approved March 19, 1918). Eastern Standard Time is the Mean Time of the 75th Meridian and Is Five Hours Behind Greenwich Mean Time. Central Standard Time Is the Mean Time of the 90th Meridian and Is Six Hours Behind Greenwich Mean Time. Mountain Time Is the Mean Time of the 105th Meridian and Is Seven Hours Behind Greenwich Mean Time. Pacific Time is the Mean Time of the 120th Meridian and Is Eight Hours Behind Greenwich Mean Time. By Act of Congress the Legal Time for Each Belt is the Time of the Standard Meridian for that Belt. A Person Traveling From One Time Belt Into the Next Adjacent Belt Must Change His Watch Time by One Hour, SETTING IT FORWARD ONE HOUR IF HE IS TRAVELING EASTWARD and Back One Hour If He is TRAVELING WESTWARD to Agree With the Time of the Belt Into Which He Is Passing. The Legal Standard Time for Alaska Is That of the 150th Meridian and Is Ten Hours Behind Greenwich Mean Time.

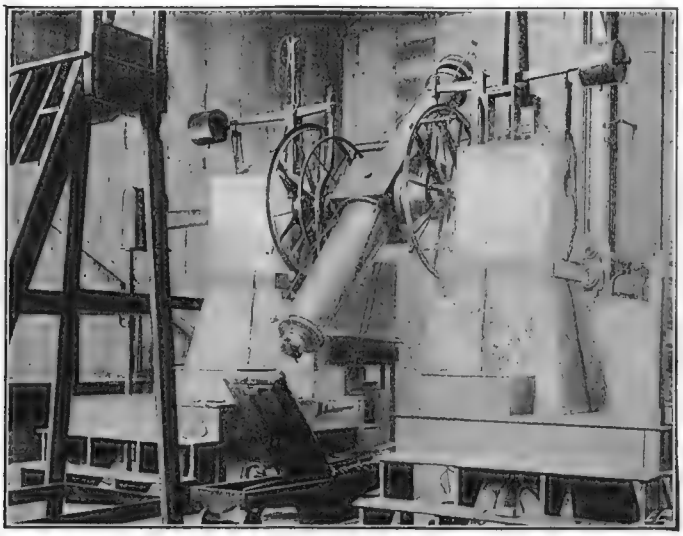
cessive transits of the mean sun over the meridian, and it is mean noon when the mean sun is on the meridian. The interval from the transit of the mean sun to that of the true sun or vice versa never amounts to more than sixteen minutes, and it is spoken of as the *"Equation of Time."* Four times a year its value becomes zero, and then mean noon and true solar noon coincide.

It is, of course, impossible to make observations of a fictitious body, but mean solar days are as invariable as sidereal days in length and sidereal intervals can be converted into mean solar intervals, and vice versa. A mean solar day is longer than a sidereal day by approximately three minutes and fifty-six seconds. So the vernal equinox or a star comes to the meridian three minutes and fifty-six seconds earlier each day, and sidereal noon, therefore, occurs earlier each day by this same amount.

In practise the determination of time takes the form of finding the correction to a sidereal clock by recording the time it registers when some star, whose position is accurately known, crosses or "transits" the meridian. The star's "Right Ascension" when on the meridian is the sidereal time at that instant (see Fig. I), and a direct comparison of this time with that shown by a sidereal clock at the same instant gives the correction to the sidereal clock. The corresponding mean solar time is then found by a simple conversion from sidereal into mean solar time.

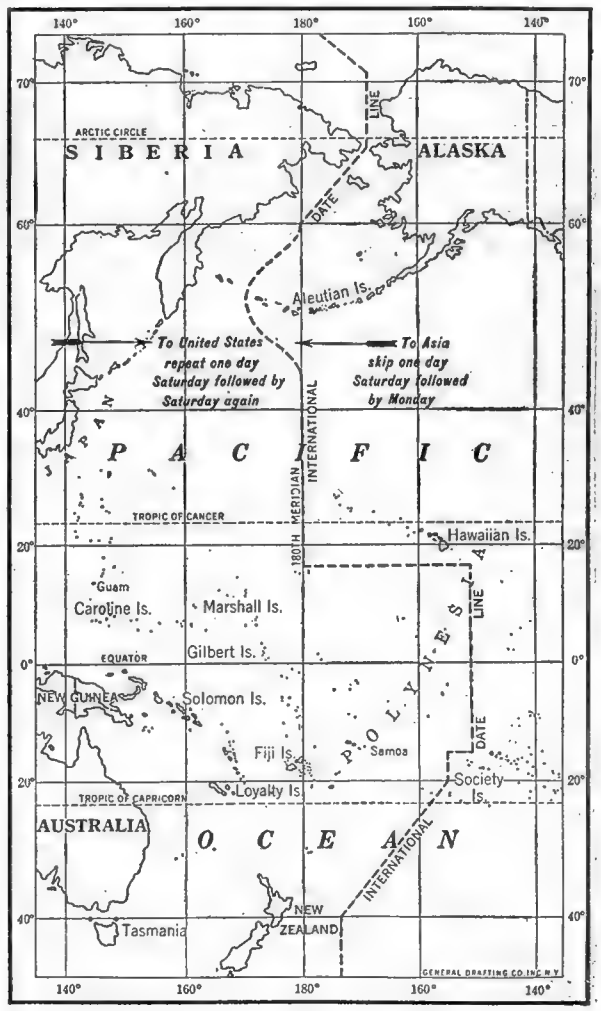
To make this determination of time as just outlined, the astronomer needs,—the accurate positions of the stars to be observed, which are to be found in the Nautical Almanac, a transit telescope, which is designed for the express purpose of ob-

(*Continued on page* 1170)



The Nine-Inch Meridian Transit of the U. S. Naval Observatory Used for "Time Sights" and Also for Regular Observations of the Meridian Passage of the Sun, Moon and Planets.

As the Sun Moves From East to West In its Daily Circuit of the Earth, It Is Evident That It Will Cross the More Easterly Meridians First. When It Is On the Meridian of Greenwich It Is Greenwich Mean Noon There, But It Is Not Yet Noon On Meridians West of Greenwich and It Is Past Noon On Meridians East of Greenwich. That is the Time of Places West of Greenwich Is Behind Greenwich Time Or "Slow On Greenwich" and the Time of Places East of Greenwich Is Ahead of Greenwich Time or "Fast On Greenwich." Of Course the Greater the Difference in Longitude the Greater the Difference in Time. The Farther West We Get the More We Fall Behind Greenwich Time and the Farther East We Get the More We Get Ahead of Greenwich Time. This Change In Time Is One Hour For Every Fifteen Degrees of Longitude, So By the Time We Have Reached the 180th Meridian West of Greenwich We Have Fallen Behind Greenwich Time By Twelve Hours. If It Is Greenwich Mean Noon When We Reach the 180th Meridian It Is By Our Clock Twelve Hours EARLIER or the Preceding Midnight; But If We Have Traveled Eastward From Greenwich to Reach the 180th Meridian We Find We Are Twelve Hours Ahead of Greenwich Time. It Is Therefore Midnight. As in the First Case, by Our Clock But the FOLLOWING Midnight Instead of the PRECEDING. That Is, It Depends From What Direction We Are Approaching the 180th Meridian Whether Our Clock Is Twelve Hours SLOW on Greenwich Time or Twelve Hours FAST on Greenwich Time. Two Ships Approaching the 180th Meridian From Opposite Directions Will Therefore Find a Difference of Twenty-four Hours In Their Time.



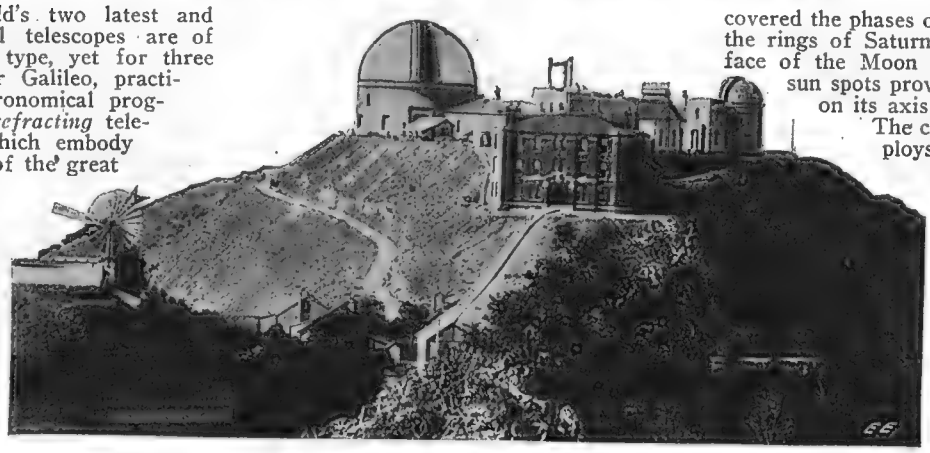
World's Big Telescopes

By FLOYD L. DARROW

Head of Science Department, Polytechnic Preparatory School, Brooklyn, N. Y.

No. 3 REFRACTING TELESCOPES

ALTHO the world's two latest and most powerful telescopes are of the *reflecting* type, yet for three centuries after Galileo, practically all astronomical progress was made with *refracting* telescopes, instruments which embody the optical principles of the great Italian physicist and astronomer.

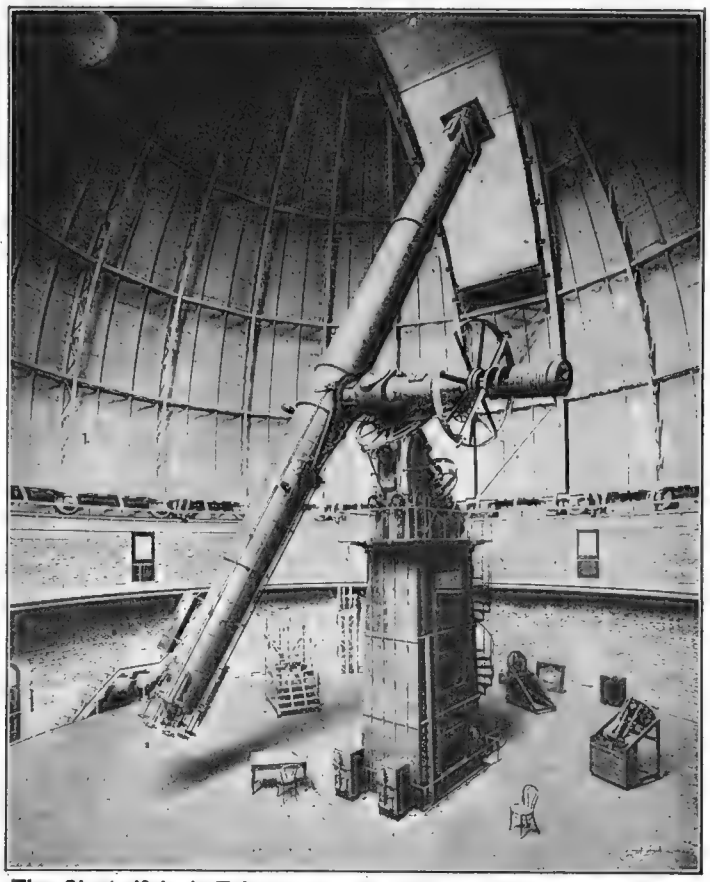


The Famous "Lick" Observatory, Situated at Mt. Hamilton, California.

Galileo's "Optical Tube," as he called his telescope, consisted of a lead tube, in one end of which was a double convex object glass and in the other a double concave eyeglass. With this first crude instrument he brought objects *three times nearer and made them appear nine times larger.* He quickly made other glasses, each of higher power than the preceding and in a short time had a telescope that brought objects *thirty times nearer* than when viewed with the unaided eye. With this instrument Galileo made his epoch-making discoveries in astronomy. To his amazement, he found that he could count ten times as many stars as he was able to detect with the naked eye. He came to the conclusion that the stars were not all equidistant from the earth. The stars revealed by his telescope must be at greater distances than those seen without its aid. Turning his magic tube on the beautiful *Milky Way,* he resolved this belt of hazy fire mist into a myriad of stars too faint to be distinguished without optical aid and at such measureless distances that they literally seemed to rub elbows with each other. And yet we know that this galaxy of stars represents innumerable blazing suns separated from each other by millions and millions of miles! A little later Galileo made the first real astronomical discovery, that of the four moons of Jupiter. Here, indeed, was a miniature solar system with its central sun and family of revolving planets. Surely, the teaching of Copernicus, making the sun and not the earth, the center of our solar system must be true. Quickly following this Galileo discovered the phases of the planet Venus and the rings of Saturn. He studied the surface of the Moon and by observation of sun spots proved that the sun rotates on its axis as does our earth.

The common opera glass employs the same system of lenses as did Galileo's telescope. To understand how images are produced by its aid we must know the meaning of *refraction of light.* Everyone has observed the fact that an oar placed obliquely in water appears to be bent at the waterline, or that a line of type viewed thru a thick piece of plate glass seems to be shifted. These and many other similar effects are due to the bending of light rays as they pass from a medium of one density to a medium of greater or less density. When a ray passes from a medium of greater density to one of less density, it is bent away from the perpendicular at the point of incidence or emergence but in passing from a less dense medium to a more dense one it is bent toward the perpendicular. The point from which the light proceeds seems to be in the direction of the refracted ray which enters the eye and consequently above its true position. Now it is in the power of glass similarly to bend light rays that its optical properties lie. The accompanying figure,

The Great 36-Inch Refracting Telescope of the "Lick" Observatory, Shown Above. Note Size of Men.



The Giant 40-Inch Telescope of the "Yerkes" Observatory. Note Comparative Size of Chair.

Fig. 1, shows the refraction of a ray of light in passing thru a triangular glass prism. In principle a double convex lens with which images are produced is really two triangular prisms placed base to base.

There are two kinds of images which lenses produce—real and virtual. A stereopticon picture is an illustration of a real image, for it may be focust upon a screen and is produced by the actual meeting of the refracted rays of light at the place where the image appears to be. A virtual image is not formed by the actual focusing of light rays, but by diverging rays which would meet only if produced in the opposite direction. A *virtual* image cannot be caught on a screen and is upright, whereas a *real* image is always inverted in respect to the object. An ordinary plane mirror gives an example of a virtual image. Both types of images are illustrated in telescopes.

Lenses are of two main types, converging and diverging. The convex lens is of the former class and the concave of the latter. As shown in the diagram, Fig. 2, of Galileo's telescope the object glass converges the rays of light from the object AB, tending to form a real, inverted image at ab. But before the rays reach this point they are diverged by the concave eyepiece, thus preventing the rays ever from actually meeting. In looking thru the eyepiece, however, they do seem to meet at A'B', and therefore produce a virtual magnified image in that position. *The object glass always produces a REAL image and the eyeglass a VIRTUAL image.*

Very early in the making of *refracting* telescopes a serious difficulty presented itself. White light, which is ordinary sunlight, is composed of all the colors of the rainbow and Sir Isaac Newton discovered that prisms and lenses bend rays of different colors unequally. The violet rays are refracted most and the red least. Therefore, when light is reflected into a telescope it is dispersed by the object glass into its component colors and the violet rays are brought to focus sooner than the red. As a result the whole image is surrounded by a troublesome *color fringe.* To overcome this difficulty lenses were ground almost flat and of very great focal length, but an even more serious obstacle immediately appeared. Such flat lenses necessitated very long and unwieldy telescopes, awkward to manipulate and requiring a prodigious amount of time and patience in their use. There were instances of telescopes over two hundred feet in length and with no tube connecting object glass and eyepiece.

The first achromatic lenses, which overcame this difficulty, were made by two English opticians, Chester More Hall and John Dolland about the middle of the eighteenth century. They accomplisht this by making an object glass of two lenses instead of one. They cemented a double convex lens of crown glass to a plano-concave lens of flint glass. The flint glass being more dense has greater refractive power than the crown glass. Therefore the concave flint glass diverges the rays of light just enough to neutralize the color effect of the converging crown glass, and yet not enough to prevent the formation of an image. With this most important discovery progress in the construction of refracting telescopes became rapid and certain.

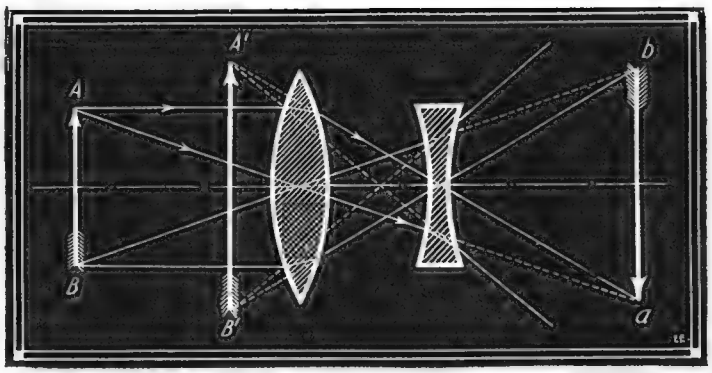


Fig. 2. System of Lenses Used In Galileo's Telescope.

In the accompanying figure No. 3 is shown the lens system of an astronomical telescope. The object glass gathers light from some distant object and bring it to focus within the focal length of the eyepiece, producing there a *real inverted image.* The light, however, does not stop there, but passes on thru the eyepiece, which diverges the rays and therefore produces a virtual image, seen only by looking into the eyeglass. An astronomical telescope will magnify only in the case of heavenly bodies within our own solar system, such as, the Moon, the planets and their satellites, the asteroids and comets. Even the nearest star is so distant that our largest telescopes are utterly powerless to magnify it in the slightest. *What a big telescope does is to gather more light and produce a very bright image.* It also makes visible many millions of stars that would otherwise be unseen and by celestial photography discovers millions more. The big 40-inch lens of the Yerkes telescope gathers 40,000 *times as much light as is possible with the unaided eye.*

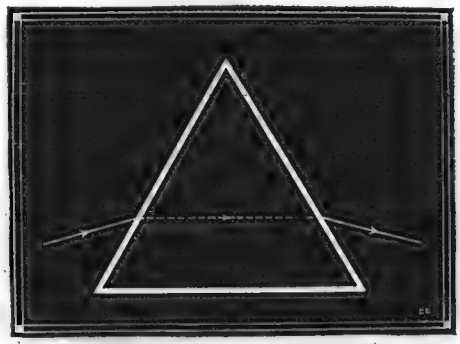


Fig. 1. Illustrating Refraction of Light Thru a Glass Prism.

An astronomical telescope gives an *inverted* image, which of course is unobjectionable in viewing heavenly bodies. The terrestrial telescope, however, contains a third system of lenses for reinverting the image so it will appear upright. This system in an astronomical telescope would cause needless loss of light.

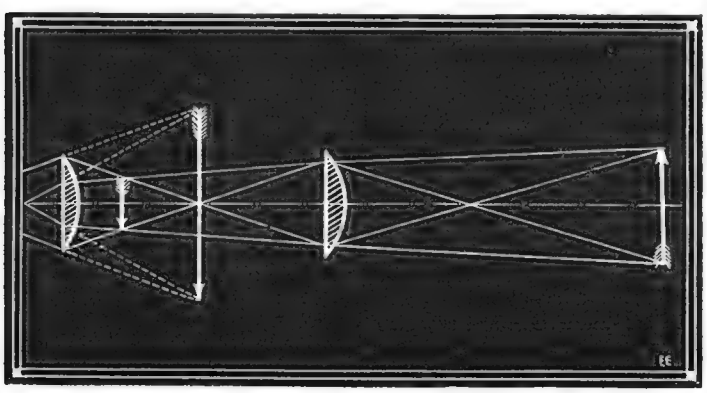


Fig. 3. Here We See the System of Lenses Used In an Astronomical Telescope.

TWO GREAT REFRACTING TELESCOPES.

Among the world's great refractors there are two of such surpassing size and power that they deserve especial mention. I refer to the 36-inch glass at the Lick Observatory, Mount Hamilton, California, and the giant 40-inch lens at the Yerkes Observatory, Williams Bay, Wisconsin.

The sight of the Lick Observatory on a plateau at the summit of Mount Hamilton is 26 miles from San José, and is reached by a road from the foot of the mountain to the summit, costing $78,000. The donor of this instrument, Mr. James Lick, in 1874, gave $700,000 for the undertaking. He hoped that not more than $400,000 would be needed for the telescope, housing and buildings, thus leaving a fund of $300,000 for maintenance. The cost of construction, however, was $600,000. Tedious delays followed the announcement of the gift and actual work did not begin until 1880. The observatory was completed in 1887 and formally turned over to the University of California in 1888.

Feil and Company of Paris cast the glass from which the lenses were ground in 1882. But the crown glass was cracked in packing and two years more were spent in recasting the block. It was shipt to America in 1885.

Alvan Clark and Sons of Cambridgeport, Mass., the most famous lens grinders of all time, were engaged to do the very exacting work of shaping and figuring the glass. It was stipulated that this objective should exceed in size any other previously made. The largest glass at that time was the 30-inch lens in the Imperial Observatory at Pulkowa, Russia. The Clarks finally agreed to undertake the grinding of a 36-inch glass, but could not be induced to go beyond that limit. The consideration for the work was $50,000 and they spent a year in doing it. In the meantime the Warner and Swasey Company of Cleveland were constructing the dome and mounting. The telescope and its accessories cost $200,000.

The telescope is 60 feet long and the tube alone weighs 4 tons. It rests upon an iron pier 37 feet high, the base of which contains the sepulcher of the benefactor who made possible this splendid work of science. So perfect is the adjustment of the mechanism that it may be manipulated as easily as an opera glass. The observatory dome comprises 89 tons of movable structure and is 87 feet in diameter. The sight contains 2,581 acres and the broad plateau comprising it is reached by a series of stairs from the flat below. From this high elevation unrivaled views of mountain, plain and sea greet the eye and the clear air of this region is unexcelled for telescopic "seeing."

The observatory is fully equipt with spectrographic and photographic attachments for the big telescope, besides all other necessary accessories. One of the notable discoveries made at Mount Hamilton was that of the minor planet, *Eros,* in 1898.

The Yerkes Observatory, which contains the world's largest refracting telescope, is located on a tract of 53 acres at the summit of a succession of hills on the shore of Lake Geneva in southern Wisconsin, 75 miles from Chicago. The center of motion of the telescope is 240 feet above the surface of the lake and 1,800 feet distant from the shore. The observatory is far

(*Continued on page* 1207)

The Amateur Magician

By JOSEPH H. KRAUS

THE "TALKING SKULL"

ON one of these fine mornings when the snow and slush prevents traffic in the city streets, an ideal way for killing time (which I never have) occurred to me, namely, to see about another—er—bit of news from Professor Hargrave. Scurrying to his room in a New York hotel, where he lives during the winter season, as the railroad traffic was abominable, I found him busy over the remains of some departed friend.

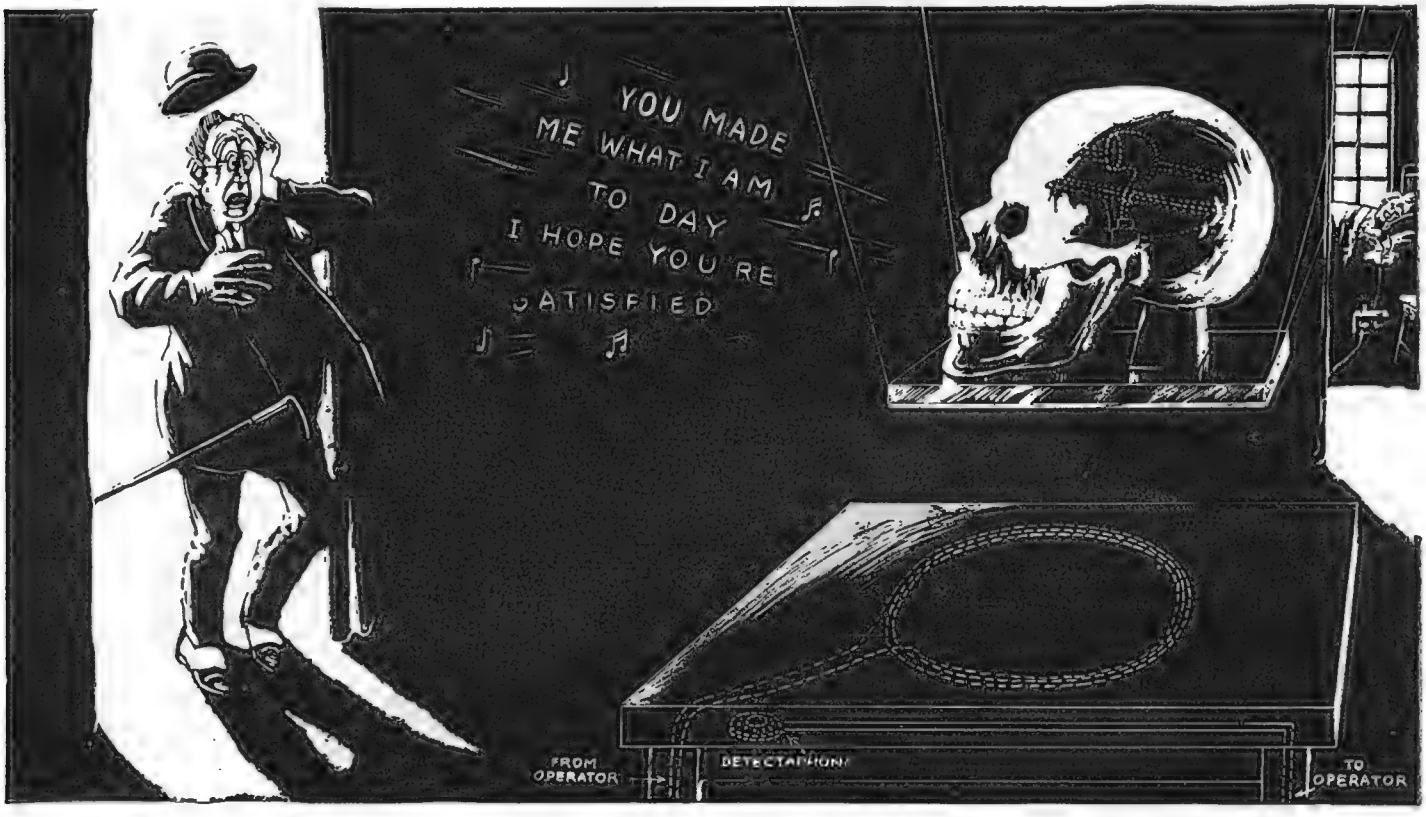
There on the table with tools lying all around it, rested a "skull"—of what he claimed to be that of his Mother-in-law (sob stuff). After the casual greeting, he begged me to be seated while he proceeded to dismember the cranial vault and then tinkered around it some more. All the while not saying a word. Finally, he exclaimed, "There now, I've got it," and then looking toward me, he remarked—"I didn't expect you this early, but I finally got it all set up for you. How do you like it?" I must say that the skull seemed very impressive. There it stood with its teeth grinning at me and the most villainous look upon its face. It was reposing quietly on a glass shelf, suspended about six inches above a polished table by means of four wires coming down from a bracket-like arrangement.

The point of its chin resting well forward and the back of the head in the region of the great foramen on a sort of a block. You could look all around it. After this cursory examination, I turned to the professor and said, "It looks mighty fine but kind of scarecrow like. What does it do?" "N-O-T-H-I-N-G." This in a loud weird voice which I knew never came from the professor. The voice was in that very room—in front of me—on the sides—all around me! I trembled a moment and then exclaimed, "What was that?" Again the sound and a pleased twinkle in the eyes of the professor. Ah! Now I knew what it was! Tip-toeing up to the skull, I lifted it easily in order to disconnect the wires which I thought were leading to it. To my amazement, it emitted a fearful howl which came from right within the inside. Did I drop it? Well I should say so. To go into a dimly lighted room and see a skull and in lifting it up hear it talk is enough to make anybody depart, rather in peace than in pieces.

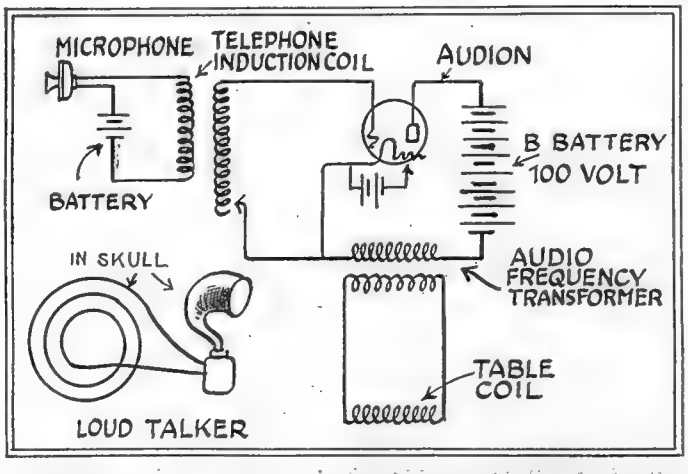
In my haste to get away, I was caught by the professor, just as I stumbled over a little footstool. Turning me around quickly, he stated, "That is my new trick and it's extremely simple, too. You see, you can use this in conjunction with any card trick, clairvoyant act, or in fact any fortune telling or other scheme."

"The skull has absolutely no electrical connections to it of any sort," he continued as he lifted it from the table, passing his hands all around it, back and in front, and allowing me to examine it. Then continuing, he stated—"Still, when I talk to it, it will answer back," and addressing the skull, said, "How do you do, Mother-in-law?" "How do I do what?" came back

(*Continued on page* 1198)



What the ——? ——? Exclamations of This Nature and Then Some, Emanate from "Friend Hubby" When Wifey Tries the "Talking Skull" Trick On Him. This Is One of the Finest Tricks (Undetectable) for Parlor Magic.



A Detectaphone Tells the Operator What Is Going on In the Room. The Operator Then Transmits His Answer Which Is Amplified In the Audion Cabinet. By Induction the Loud Talker In the Skull Answers. No Connections Lead to the Skull.

Rabbit Contest Awards

PRIZE WINNER $20.00.

In explanation of the phenomenon associated with the "Rabbit Film" on page 798 of the ELECTRICAL EXPERIMENTER, I submit the following:

The moving picture machine that exposed this film took the pictures at the rate of about sixteen per second. The time of exposure, i. e., the time the shutter was open, was a small fraction of a second, probably 1/100 of a second or less. The corona occurs only when the A.C. supply wave nears its maximum value, for then the spark gap breaks down and the condenser charge is released thru the Tesla coil. This discharge sets up the oscillating current of high frequency and high potential producing the corona effect. The camera exposed but a small part of about every fourth cycle. Some of the pictures, therefore, were taken while the A.C. wave was passing thru its zero value—hence negative was blank. Others were taken when the wave was nearing its maximum value and therefore some of the pictures showed streamers. The one with the rabbit shown plainly *was taken at exactly the right time*, i. e., while *the wave was passing thru its maximum value* and when the oscillating current and consequent corona were at their best.

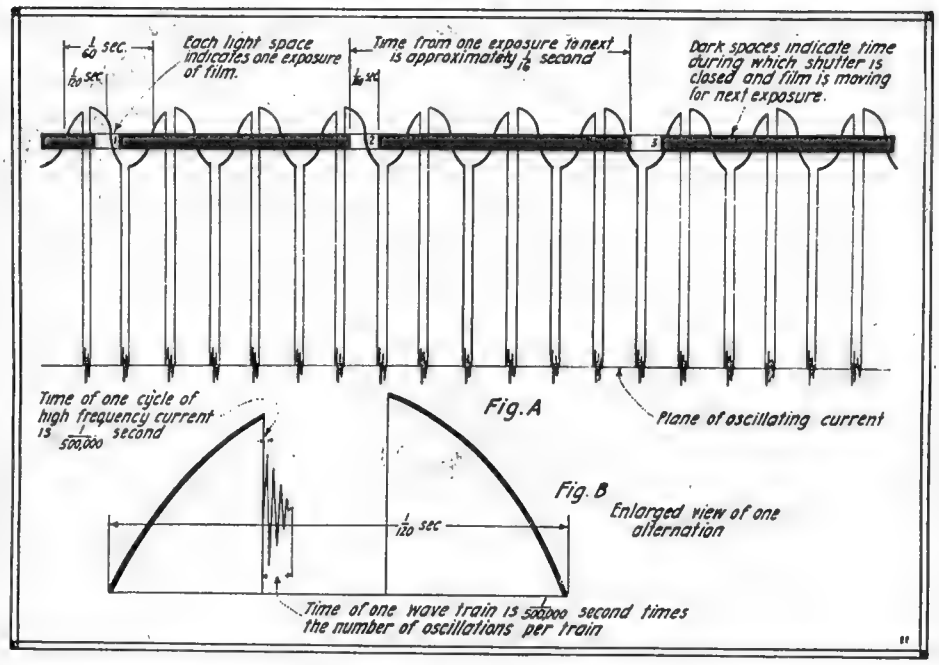

1/60 sec.
1/60 sec
Each light space indicates one exposure of film.
Time from one exposure to next is approximately 1/6 second
1/6 sec
Dark spaces indicate time during which shutter is closed and film is moving for next exposure.
1
2
3
4
Time of one cycle of high frequency current is 1/500,000 second
Fig. A
Plane of oscillating current
Fig. B
Enlarged view of one alternation
1/120 sec
Time of one wave train is 1/500,000 second times the number of oscillations per train

Diagram to Accompany Mr. Leffler's Prize Winning Solution.

This phenomenon is illustrated graphically in Figs. A and B. Fig. A shows the A.C. wave, also the time during which the camera shutter was open. The third exposure is at the right time to give a good picture on the negative, like for example the sixth picture of the film under discussion. The second and first exposures, however, were not at the right time and therefore only the streamers would show.

Fig. B gives an exaggerated illustration of the length of time occupied by the high frequency oscillating current in comparison with one alternation of the A.C. supply.

RALPH H. LEFFLER.

105 Wurst Ct.,
Elyria, Ohio.

FIRST HONORABLE MENTION.

The frequency of 200,000 used in electrifying the rabbit means that the alternating current used alternated 400,000 times per second. To the eye such an electrical discharge appears as a continuous and even light, but it is well known that the light is not continuous but fluctuates from light to darkness 400,000 each second.

The moving picture camera that photographed the experiment took approximately sixteen separate pictures per second, each one of these pictures having an exposure of perhaps 1/200 of a second.

The reason that each picture in the film doesn't give full details of the rabbit is because the various exposures of the film didn't come at the same time that the light from the rabbit was at its height or peak of intensity—that is, several of the pictures were exposed between alternations of the current producing the light.

In the first five pictures the opening of the camera shutter happened either at the beginning or end of an alternation, thus causing an incomplete picture to be recorded. In the fifth picture the exposure came at the time when the alternation was at its peak of luminosity, thereby producing a detailed photograph.

If the camera exposures could be timed to coincide with the alternation peaks, the film would show a series of complete photographic impressions—that is, if the camera could open its shutter 400,000 times per second and each opening took place at the exact instant that each one of the 400,000 alternations was at its peak, each picture would then be fully exposed and complete; or a camera shutter having 1/200 of a second exposure would have to be timed so that each exposure would catch each 100th alternation at its peak in order to have a complete picture upon each frame of the film.

WALTER CHARLES MICHEL.

1023 Summit Ave.,
Jersey City, N. J.

The Mysterious Rabbit

In our December issue we offered a prize for the best solution of a section of a film which we made of a rabbit.

We said in the December issue:

"Turn to page 633 of our November issue. We told you last month how we electrified a rabbit with 500,000 volts, and how he never batted an eyelash. Well, sir, the Gaumont Film people who got wind that we were pulling off a stunt were duly on hand with their trusted film cameras, and while we made the experiment the operator cranked away merrily. Of course, we wanted to see what the film looked like and we had our wish. The very mysterious sample slightly enlarged from the original is printed alongside here. At first we were somewhat puzzled and could not quite make it out how the long streamers after the third picture died away into a mere brush and in the fourth picture had almost entirely vanished only to bloom forth in a wonderful corona effect, showing the rabbit very plainly in the sixth picture. In the seventh and eight, however, nothing can be seen. Now what do you think happened?

Five hundred thousand volts at 20 kilowatts with a frequency of 200,000 was used in the film printed here, which is absolutely authentic. WE WILL PAY $20.00 FOR THE BEST ANSWER EXPLAINING THIS PHENOMENON. Anyone familiar with alternating current should have little trouble in solving the problem. The contest is open to all and will close promptly on February 1, 1920. Not more than 300 words should be used. Answers will be publisht in our March issue. Address all replies to Rabbit Editor, care of this publication."

In answer to this contest we received no less than 1,675 letters, all of which tried to explain the interesting phenomenon which took place. Only very few, however, came up to our expectation, most of the contestants having an entirely erroneous interpretation of what took place.

There really was nothing mysterious about the film. It simply resolved itself to a thoro knowledge of alternating currents at high frequency as well as an intimate knowledge of the workings of a moving picture machine which operates at sixteen pictures per second.

In awarding the first prize to Mr. Leffler, we were led to this consideration due to the fact that the article was very clear and to the point as well as because he illustrated his letter with the best drawing that was sent in. The letters from the contestants follow.

SECOND HONORABLE MENTION.

The strange phenomenon which you recorded in your "Rabbit Film" was due to non-synchronism between the camera shutter and the alternations of the current. If the shutter had operated at a speed bearing a simple definite ratio to the frequency, the film would have been exposed at the instant of maximum discharge. The shutter speed was evidently not an exact multiple of the frequency, hence the progression from a minimum to a maximum in vividness and vice versa. A similar phenomenon would be observed in winking the eye out of synchronism with a spot on a rotating object. The object would appear to advance or retard in its rotation as the rate of winking changed. If an alternating current illuminates a fan and the speed of rotation of the fan is accelerated or retarded, the fan will at one speed appear to travel backward, at another to stand still and at still a third to accelerate. This is due to the fluctuations of the intensity of light due to the alternating current. The maximum intensity is reflected by the fan blades at varying positions in advance or behind the former position depending on the ratio between the speed of the fan and the alternations. Conceivably if the shutter in the case of the movie had operated at a certain speed maximum and minimum intensity of discharge would have resulted.

A similar picture with the slow movie would no doubt reveal the phenomenon still more vividly.

ARTHUR J. MACER.

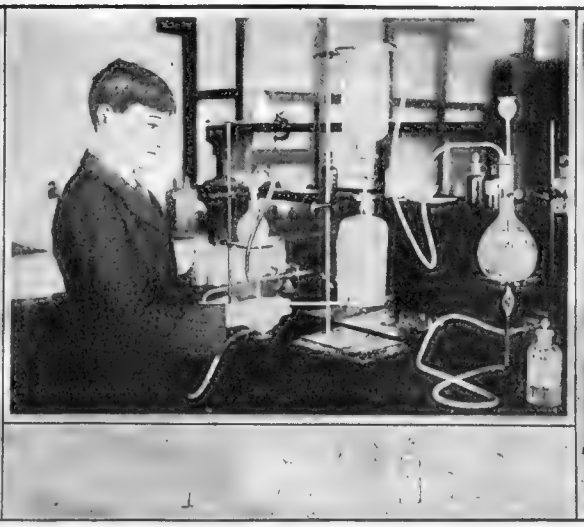
3722 M St.,
Westfield, New York.

(Further letters will be publisht in the April issue.)

Practical Chemical Experiments

By PROF. FLOYD L. DARROW

A Baffling Color Change Trick. Fully Described in the Test.



Performing the "Smoke Ring" Trick. A Most Interesting Stunt.

Siphoning Carbon Dioxid Gas. The Candle Test Proves the Experiment.

No. 2.—Chemical Stagecraft

THE Amateur Chemist, working in his home laboratory, probably derives more pleasure from entertaining his friends with experiments in "chemical magic" than he does from any other part of his laboratory work. Such demonstrations, too, are so easy to perform and so mystifying to the uninitiated that *chemical stagecraft* affords a never failing source of amusement, both for the demonstrator and his audience.

In this paper and perhaps in a succeeding one a number of very striking experiments of this nature will be described.

THE MAGIC WAND.

A color change requiring a considerable time to make its appearance and which may be so timed as to take place at the exact passage of the demonstrator's wand over the magic mixture never fails to make a most profound impression.

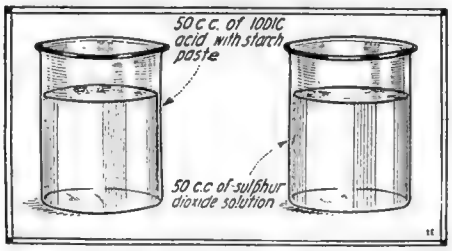


Fig. 1. Apparatus for the "Magic Wand" Trick.

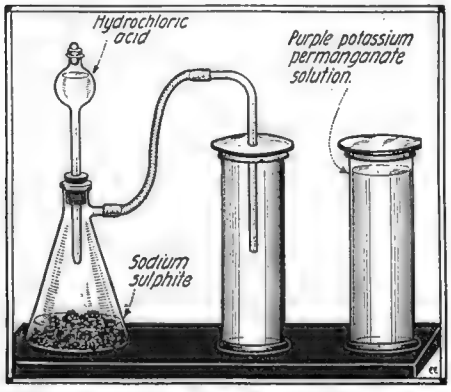


Fig. 2. Apparatus Used in "Baffling Color Change" Experiment.

Two solutions are required. One is made by dissolving 10 grams of iodic acid in a liter of water, which may be preserved in a glass-stoppered bottle for a series of demonstrations. To make the other solution, saturate 50 cubic centimeters of water with sulfur dioxid by bubbling the gas thru it for a few minutes. The best way to generate the sulfur dioxid is by allowing concentrated hydrochloric acid from a dropping funnel to fall onto sodium sulfite in a hydrogen generator. Of this saturated solution of sulfur dioxid, 25 cubic centimeters are diluted to a liter and preserved in a stoppered bottle.

In each of two beakers place 250 cubic centimeters of water. To one add 50 c.c. of the iodic acid solution and to the other 50 c.c. of the solution of sulfur dioxid. Now make a thin starch paste by boiling as much starch as can be placed on the point of a small knife blade in 25 c.c. of water. Add a few drops of the starch paste to the solution of iodic acid. Stir the contents of each beaker thoroly and rapidly pour the two together into a large cylinder or beaker capable of holding 700 c.c. With a clean glass rod stir well to insure thoro mixing of the liquids.

Nothing appears to happen for about a half minute and then instantly the contents of the whole cylinder will turn a deep blue. By trying the experiment in advance *the exact time interval, almost to a second,* may be determined, and when the psychological moment arrives, the demonstrator may wave his wand and behold the contents of the cylinder become subject to the magic spell and the color change occurs. See Figs. 1 and 1-A.

What happens is this: The sulfurous acid reduces the iodic acid, liberating free iodine which reacts with the starch to give a blue color.

A BAFFLING COLOR CHANGE.

A decolorization experiment which appears to be magic pure and simple is accomplisht by pouring a wine-colored solution of potassium permanganate from one cylinder into another containing sulfur dioxid gas.

Place two or three small crystals of potassium permanganate in the bottom of a 500 c.c. cylinder and fill with water. Stir thoroly and a beautiful wine-colored solution will result. Now generate sulfur dioxid as in the previous experiment, and fill another cylinder of equal size with the gas by downward displacement, i. e., place the delivery tube downward into the cylinder. Cover this cylinder with a glass plate. See Fig. 2.

Make these preparations in advance of assembling your audience. Show them that the cylinder of sulfur dioxid is "empty," perfectly dry—contains nothing at all. Then pour the cylinder of potassium permanganate solution which you may call "wine" into the empty cylinder, and as you do so it instantly changes to "water." The chemical action taking place consists in the reduction of the potassium permanganate into a colorless compound by the sulfur dioxid.

A still further change can be effected by adding to the decolorized solution a little of a solution of farium chlorid and stirring. A white precipitate of barium sulfate forms and the solution seems to be changed to "milk."

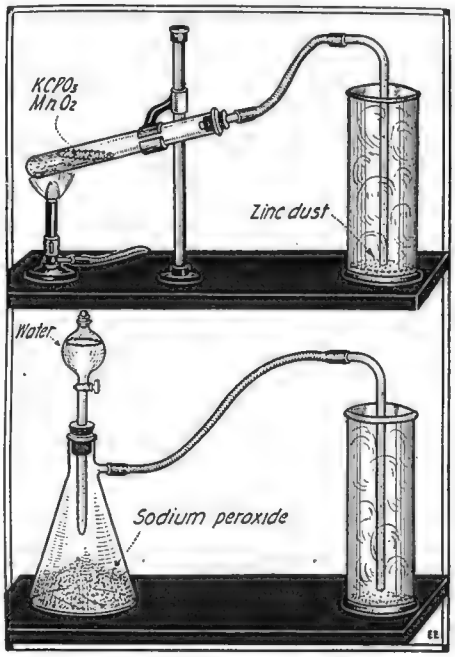


Fig. 3. Set-Up of Apparatus for Explosive Combustion of Powdered Iron or Zinc.

SPONTANEOUS COMBUSTION.

Make a solution of yellow phosphorus in carbon disulfid by dissolving a piece the size of a pea in 10 c.c. of the liquid.

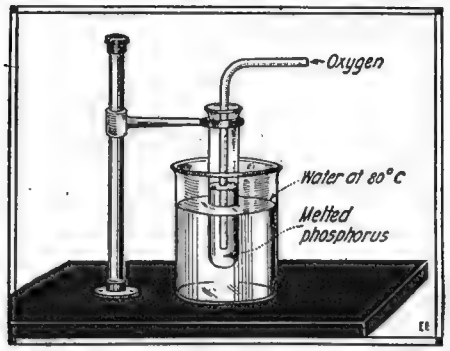


Fig. 4. Burning Phosphorus Under Water. An Interesting Experiment.

(*Do not handle phosphorus with the fingers. Use pincers.*)

Pour a little of this solution onto a filter paper or piece of a blotter. Then wave the paper back and forth thru the air for a few moments when it will burst into flame and burn to a crisp.

As the carbon disulfid evaporates, phosphorus is left in finely divided state over the surface of the paper and its rapid oxidation quickly brings it to the kindling point.

LIGHTING AN ALCOHOL LAMP WITH A GLASS ROD.

In the bottom of a small beaker place 1 gram of powdered potassium permanganate and moisten with a few drops of water. Add 2 c.c. of concentrated sulfuric acid. A vigorous action immediately takes place and a glass rod dipt in the mixture and touched to the wick of an alcohol lamp will at once ignite it.

The potassium permanganate and sulfuric acid generate ozone, a concentrated form of oxygen, and this will oxidize the alcohol, bringing it to its kindling temperature.

EXPLOSIVE COMBUSTION OF POWDERED IRON OR ZINC DUST IN OXYGEN.

In the bottom of a cylinder or bottle about 6 inches high and 1¼ inches in diameter place a ¼-inch layer of very fine iron filings or zinc dust. See Fig. 3.

Set up an oxygen generator in the usual way—ring stand, Bunsen burner, test tube, one-holed stopper, delivery tube, mixture of potassium chlorate and manganese dioxid. By means of rubber tubing connect the generator with a bent glass tube reaching to the bottom of the cylinder containing the metal filings. Upon directing a rapid stream of oxygen into the bottom of the cylinder the dust will mingle with the gas and be blown upward into the cylinder.

Remove the delivery tube and apply a match to the mouth of the cylinder, when an exceedingly brilliant combustion will occur, making necessary the use of colored glasses. The effect is much heightened by performing in a darkened room.

The oxygen may be generated more easily by the reaction of sodium peroxid and water. The apparatus for doing so is identical with that for preparing sulfur dioxid. Place sodium peroxid in the generator and water in the dropping funnel. See Fig. 3.

COMBUSTION OF STEEL WOOL.

Fill a bottle with oxygen by collection over water. Remove the bottle and cover with a glass plate. To the end of a stout iron wire fasten a tuft of fine steel wool such as is used for polishing hard wood. Now heat the steel wool in a Bunsen flame until combustion begins and then thrust it into the bottle of oxygen. A very brilliant combustion and a beautiful shower of sparks will result. A darkened room adds to the effect.

BURNING PHOSPHORUS UNDER WATER.

Melt two or three pieces of phosphorus each about the size of a pea under water in a large test tube by gently heating the tube. Half immerse the test tube in a beaker of water as shown in the diagram, Fig. 4. The water in the beaker should be at 80 degrees Centigrade. Insert a piece of clay pipe-stem in the test tube and conduct thru it a gentle stream of oxygen. As the oxygen comes in contact with the melted phosphorus, the phosphorus burns brilliantly, affording a very striking demonstration of fire under water. A clay pipe-stem must be used because a glass tube would break.

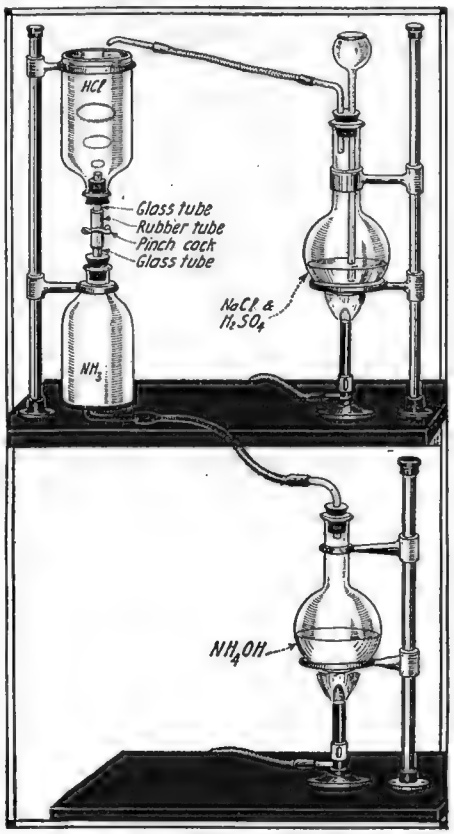


Fig. 9. The "Smoke Ring" Trick. The Rings Form in the Top Bottle.

FLOATING SOAP BUBBLES.

Half fill a large tall jar or bottle with carbon dioxid gas. To generate the carbon dioxid use marble chips and dilute hydrochloric acid in a hydrogen generator, collecting the gas by downward displacement. (See Fig. 5.) Determine when the jar is half full by lowering into it a lighted candle attached to a wire. When the candle reaches the level of the gas it will be extinguished.

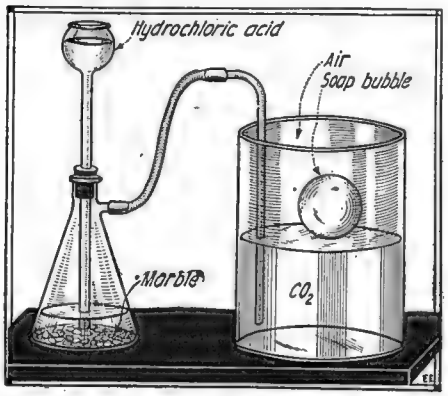


Fig. 5. An Unusual Experiment—Floating Soap Bubbles on Carbon Dioxid.

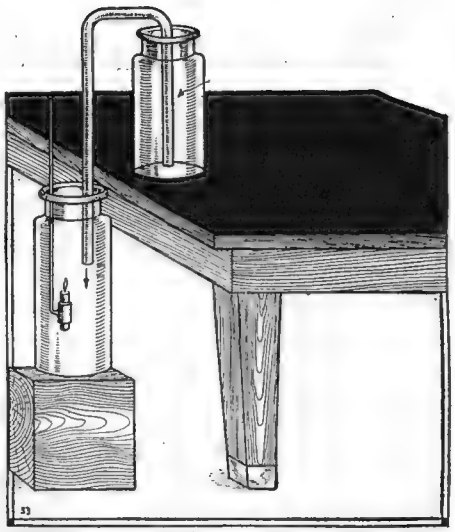


Fig. 6. Siphoning Carbon Dioxid From the Top Bottle to the Lower One. The Lighted Candle Test Proves the Success of the Transfer.

With a good soap solution and a clay pipe or thistle tube blow a bubble, and detaching it allow the bubble to fall into the jar. It will settle to the level of the carbon dioxid and there the bubble will float until it bursts.

SIPHONING CARBON DIOXID.

Fill a bottle holding about two liters (nearly two quarts) with carbon dioxid, generating the gas as in the previous experiment. Test the gas with a candle to show that the bottle is full. Bend a glass tube of large diameter into the form of a siphon and insert the short arm into the bottle of carbon dioxid. Move the bottle to the edge of the table and on a box beneath the long arm place an empty bottle of the same capacity as the other. Start the siphon in the usual way by gentle suction with the mouth and quickly raise the lower bottle so that the long arm of the siphon dips into it. With a lighted candle attached to a wire, test the gas first in one bottle and then in the other. As a result it will be shown that the heavy carbon dioxid is flowing from the upper bottle into the lower one. The candle will burn at constantly lower levels in the upper bottle and will be extinguished at successively higher levels in the lower one. See Fig. 6.

ROTATING A PAPER WHEEL WITH CARBON DIOXID.

Make and mount a paper wheel as shown in the diagram, Fig. 7. Use a stout circular cardboard and paste to it ten or twelve paper cups. Upon pouring carbon dioxid from a beaker into these cups the wheel will rotate.

Since carbon dioxid is colorless and odorless, an audience with no knowledge of the properties of this gas will be completely mystified by all these demonstrations.

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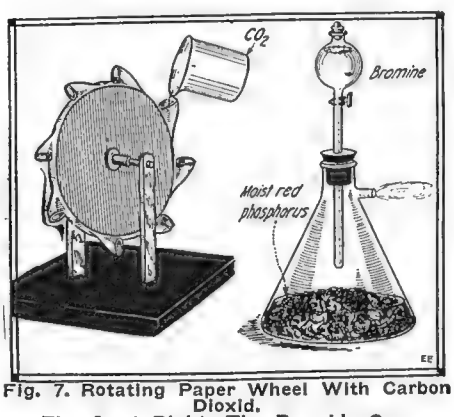
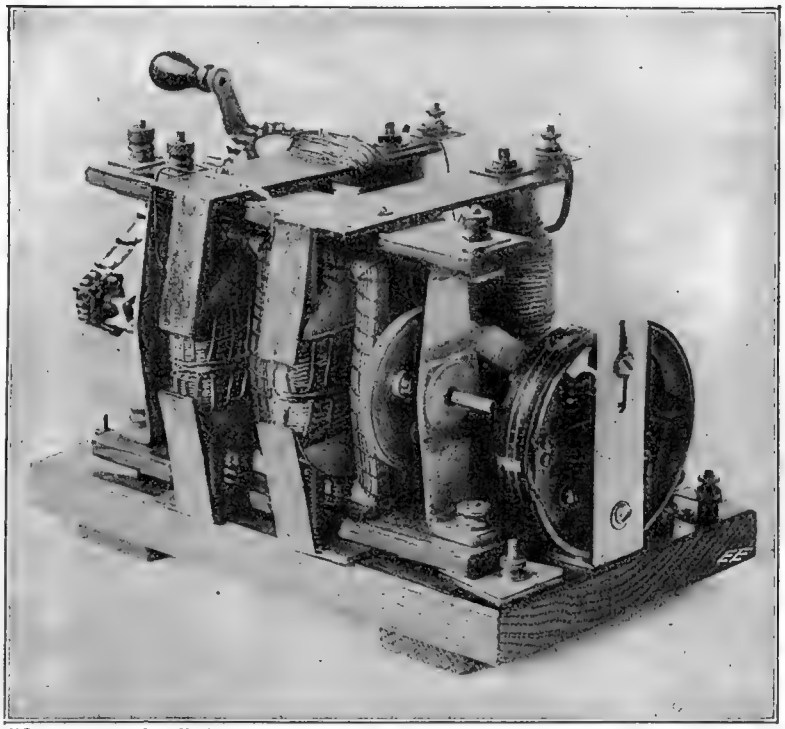


Fig. 7. Rotating Paper Wheel With Carbon Dioxid.
Fig. 8, at Right—The Bromide Gun.

New Commutator-Less A. C. and D. C. Machine

By RICHARD A. ENGLER

AN electromagnet for producing rotary, wave form magnetic fields by means of direct currents of any voltage or amperage without requiring consumption of driving power nor opening and closing contacts. All contacts are permanent, save two simple slip rings, and slip rings are all the non-permanent contacts that are necessary in any form or use of this electromagnet, and its forms and uses are many and varied. One element of the electromagnet rotates and this necessitates the slip rings. The rotation of this element causes an alternate succession of differential and non-differential dispositions of the two main elements constituting the electromagnet. This electromagnet may be called a "Homopolar" one because the same polarity travels in the same direction over a 180° arc of circle so long as the current flow in the electromagnet is not reversed or the direction of motion of one of the elements of the electromagnet is not reversed.



"Commutatorless" Alternating and Direct Current Machine Devised by the Author, Which Marks a Distinct Advance in the Development of Electro-Magnetic Machinery.—Fig. 4.

By means of this electromagnet it is possible by using direct currents, to produce rising and falling, constant value, simple alternating and polyphase alternating magnetic fields, which may all be employed as such fields usually are.

This form of electromagnet produces changes of magnetic flux in a direct current circuit without the use of any kind of troublesome and sparking interrupter or pole changers and produces true wave form magnetic fields.

Referring to Fig. 1, A, B, C and D represent four different positions obtained by the two co-operating elements as coils of the electromagnet thru one revolution of one of the coils. Noting position A in particular, magnetic poles marked N (north) will appear in each coil when the same are fed with direct current. Both coils should produce the same amount of magnetism. A resultant magnetic flux is caused thereby, which is marked N-S. This resultant rotates in the same direction as the rotating coil and its polarity remains the same over the same space, so long as the direction of current flow in the coils is not altered, but the strength of the flux varies from zero to a maximum and back to zero again in one rotation of the coil. At A the resultant flux is rising from zero, reaches a maximum at B, is falling again to zero at C and at D reaches zero from where it again begins to rise from zero. These four positions are one-quarter revolution apart.

Each succeeding revolution of the rotary coil causes a magnetic flux to rise and fall, rotate in the same direction over an arc of 180° and maintain the same polarity. This field of force having the same polarity rotating always in the same direction over the same space may be designated rightly a "Homopolar Rotating Magnetic Field."

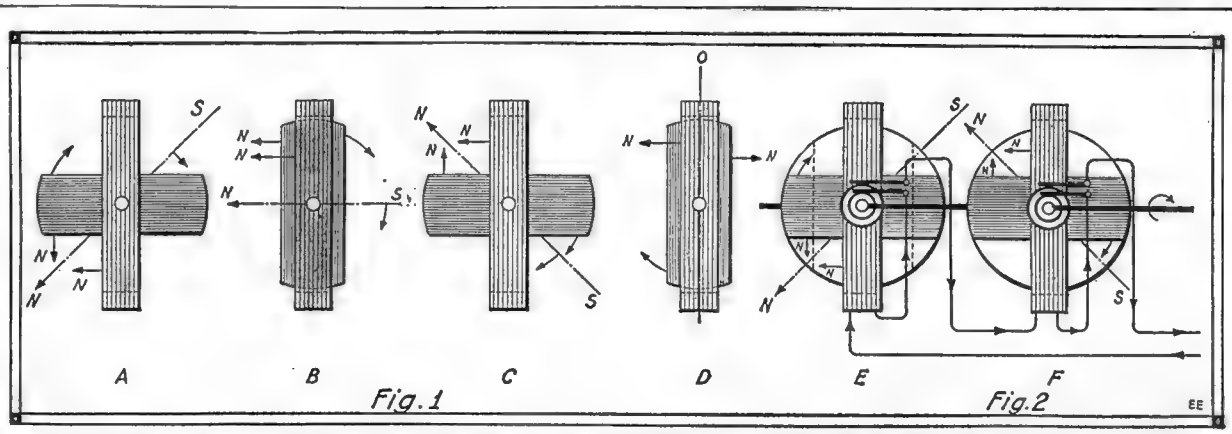
The movable coil may, however, in special cases merely oscillate over an arc of 180° to and fro, and in this case the same polarity would move up and down over the same space instead of always up or always down, hence still being within homopolar bounds. Both coils may rotate in other special cases, one in each direction, then the resultant rises and falls as before, but does not rotate, but the polarity remains fixt in space when the speed of rotation is the same for both coils. The polarity in this case is an alternating one. The rotatable coil may revolve continuously either way. One coil may rotate internally or externally of the other.

Reversing the current in the stationary coil in position A for instance reverses the polarity of the resultant and changes its position from that in A to that in C. Reversing the current in the rotary coil shifts the resultant from position shown at A to that shown in position C, but without reversal of polarity; this then is equivalent to a half revolution of the rotary coil. Reversing the current in both coils simultaneously merely reverses the polarity of the resultant without any shifting of the same.

The stationary coil requires a small per cent more wire to produce the same magnetomotive force as the rotary coil when the two coils are in series.

The two coils must be paired with a similar set in a manner to be explained presently and as shown by Fig. 2, so that no effort, other than that of overcoming friction, is required to rotate the rotary coils.

In position A, the poles produced by the two coils being at right angles to each other tend to force the coils apart to the parallel position shown at B. In position C there is the same tendency of the coils to set parallel. In position A this force would rotate the rotary coil clockwise and in position C counter-clockwise, therefore the



Figs. 1 and 2 Show Successive Positions of the Two Co-operative Elements or Coils of the New Engler "Commutatorless" A.C. and D.C. Machine.

two forces would neutralize each other. In position B, the coils and their magnetic lines of force being in open coil parallelism, no tendency to motion is produced; and in position D, the magnetic fields being in closed coil parallelism exactly neutralize each other, so again no tendency to move and also no opposition to motion in this case. Therefore, when the cooperating coils are paired as in Fig. 2, no effort, save to overcome friction, is necessary to cause the rotation of the coils and the powerful magnetic fields of force which they set up.

So it is in all intermediate positions of the two co-operating coils when paired as A-C and B-D there will be no motion produced by them, and not any opposition to motion applied to them.

Taking the two coils alone when not paired: one half revolution of the rotary coil aids any motion applied to it, while the other half revolution opposes such applied motion, hence the necessity of a pair of units such as A and C, shown by Fig. 2 as E and F, on the same shaft.

The rotary coils in Fig. 2 are each provided with an iron core, which serves also as core for the stationary coils. One way of connecting the co-operating coils is also shown in Fig. 2, but this is not the best connection because they can be so connected that one pair of slip rings *only* are needed for a pair of units.

In position A let the polarity of the resultant remain as indicated and in position C let the polarity of the resultant be reversed from that shown, then the actions and reactions between the coils of a pair of units such as A-C will still be the same as explained for the polarities when as shown, thus no power consumption.

Since the opening of the coils at A, Fig. 1, causes magnetism to appear and the rise of magnetism within a coil always induces an electromotive force counter to the electromotive force which causes the current to flow that produces the magnetism, we must look to the opening up of the two co-operating coils in all apparatus employing them as the seat of the counter-electromotive force. The faster the rotary coil revolves, the quicker will the magnetic changes take place and the higher will the counter electromotive force be.

The two units in Fig. 2 should be connected in series when used in such apparatus as herein described because then the co-operating coils in one or other of the pair of units are opening up at all times, and therefore the counter electromotive force is present at all times when it should be.

The number of turns of wire also determine the amount of counter electromotive force or self-induction in this electromagnet just the same as in an A.C. electromagnet.

The rotary coils may be driven by hand, by clockwork, by a small electric motor or any other convenient way. When an electric motor is used and with ordinary voltage and current in the co-operating coils, it may be in shunt of or series with the co-operating coils. When the voltage or current used in the co-operating coils is too great for the driving motor, it may be placed in series with a dead resistance and then both in shunt of the main line feeding the co-operating coils.

Now to illustrate one practical application of the above electromagnet, we will view Fig. 3. This figure is for the most part self-explanatory in view of what has been previously said and represents a transformer, transforming from D.C. to A.C. (and possibly vice versa). It must be imprest at the start that there is no generation of E.M.F. in Fig. 3 by the method such as in a dynamo, but such as in the ordinary static A.C. transformer. This is evident from the fact that a counter E.M.F. is generated in the co-operating coils of this apparatus when the secondaries are open just as a counter E.M.F. is generated in the primary of a static A.C. transformer when the secondary is open; or even in both cases with closed secondaries when the frequency gets too high. In a dynamo there is *no* counter E.M.F.

This figure is similar to Fig. 2, but with the polarity of one unit reversed and provided with a magnetic circuit and secondaries the several homopolar field co-operating coils being the primaries. There are shown four different positions as one revolution of the rotary coils of such a pair of units, each position a quarter revolution ahead of the other. The E.M.F.'s induced in the two secondaries cause true wave form alternating currents to flow. Fig. 3 has been demonstrated by the experimental model illustrated by the photograph. The photograph is designated as Fig. 4. The co-operating coils in the model photograph have the position shown in Fig. 2 and the rotary ones are driven by the hand gear as shown.

In Fig. 2 two pairs of slip rings are shown, but in the model Fig. 4 only one pair is used, because the rotary coils are connected in series direct, as are the stationary coils also and then stationary and rotary coils in series.

It was by means of this model that I have proven what was previously said herein.

I also used an automatic make and break, shown in the foreground in the photograph, in series with the co-operating or primary coils of the model whereby I was able to listen with a telephone receiver to all the values of induction in the secondaries from zero to maximum and back to zero during one-half wave or cycle or one-half revolution of the rotary coils.

The model is not laminated, but the results obtained with it were good nevertheless.

The secondaries were tried separately and with series, parallel and opposition connections. In the latter case one secondary E.M.F. just canceled that of the other, thereby proving the correctness of the theory of operation because different conditions exist in each of a pair of units at any given instant as explained under Figs. 2 and 3.

Any frequency can be had from Figs. 3 and 4.

In Fig. 3 the secondaries will react on the primaries, which in this kind of apparatus are the homopolar rotary field coils. When the primaries are magnetizing, the secondaries are demagnetizing, and since one set of primary coils in Fig. 3 unit two at G' magnetize by the opening up of the coils from position D to A, Fig. 1, while the other set unit one at G magnetize by a closing of the coils from position B to C, Fig. 1, it follows that the reaction of the secondaries on the primaries does not interfere with the rotating of the rotary

(*Continued on page* 1211)

In the Accompanying Figure Various Positions of the Moving Coils in the New A. C. and D. C. Commutatorless Machine Are Shown. In This Figure One Revolution of the Rotary Coils Causes One Complete Cycle or Alternation of Magnetism in the Pole Tips; That Is, a Certain Polarity Rises and Falls in One Pole Tip and the Reverse Polarity Also Rises and Falls in the Same Pole Tip, All in One Revolution of the Rotary Coils, as Becomes Evident by Carefully Studying the Successive Diagrams. As the Author Points Out, Any Number of Sets or Units, Such as Shown at Fig. 3, May Be Used and Thus Obtain Any Number of Phases by Giving Each Set a Proper Phase Displacement. "Tesla Uses a Continuous Magnetic Circuit," Says the Author. "I Use a Discontinuous Magnetic Circuit. The Lines of Force in the Magnetic Circuit Surrounded by the Coils in the Tesla System Reverse in Direction, Whereas the Lines of Force in the Magnetic Circuit Surrounded by the Coils in My System Do Not Reverse in Direction."

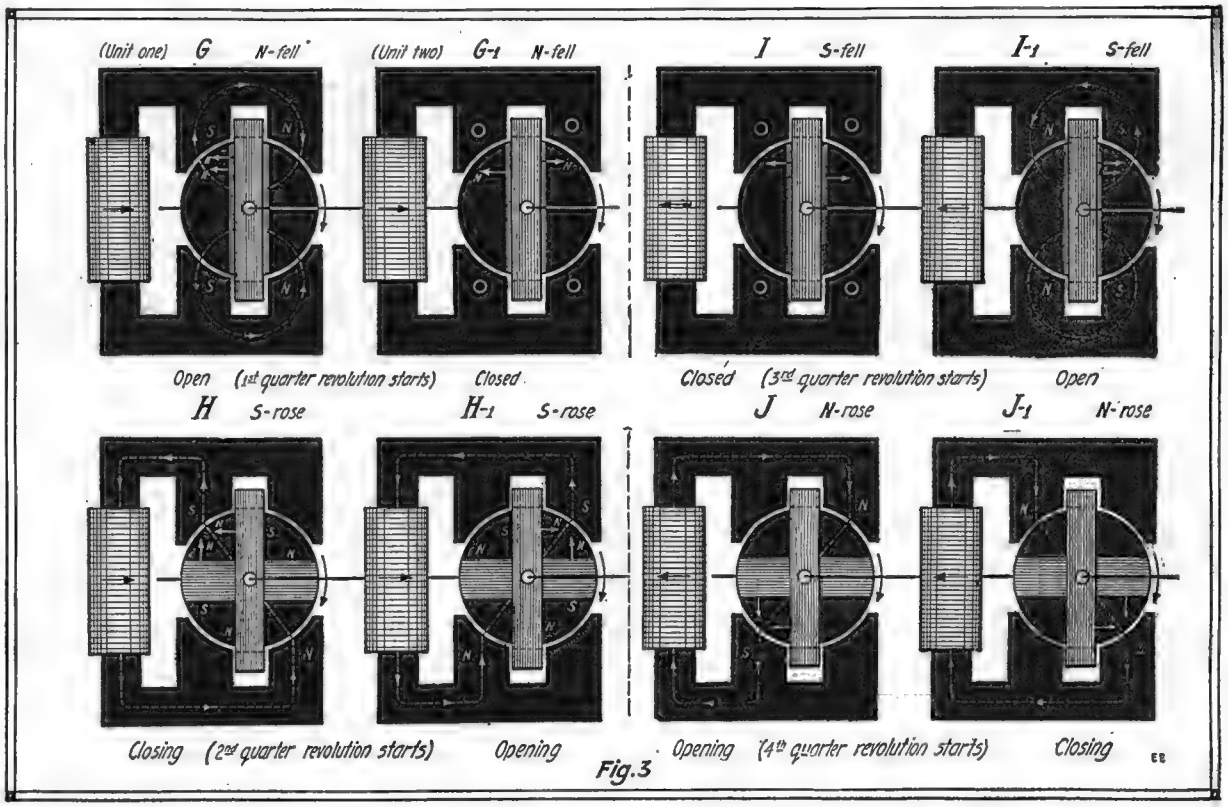
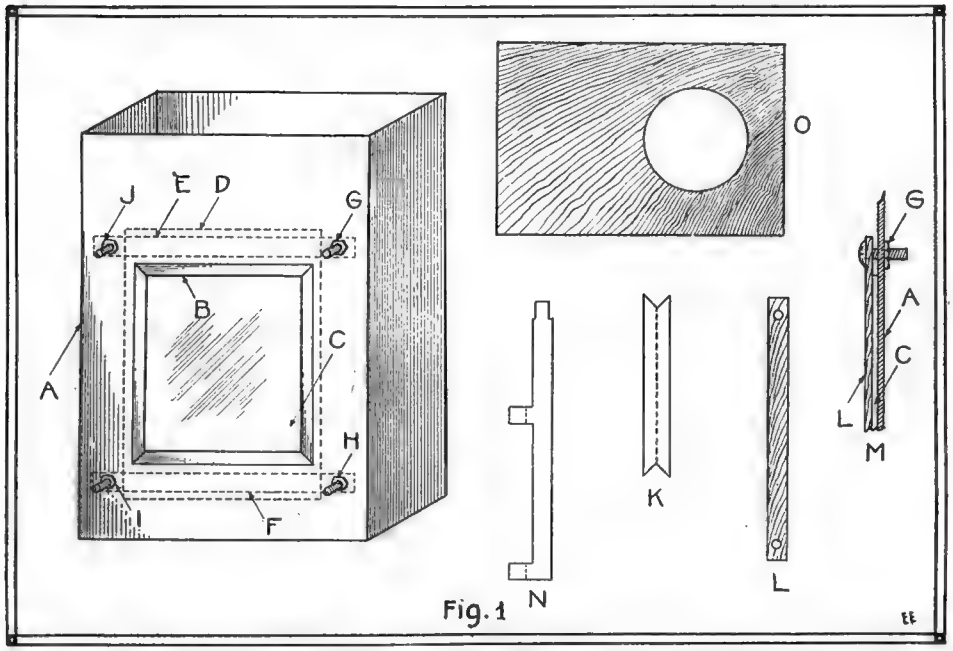


Fig. 3

THE CONSTRUCTOR

Electroscope for Radio-Activity

By FRANK M. GENTRY



Perspective View and Construction Details of Extra-Sensitive Electroscope, Useful for Tests of Radio-Activity and Ionization.

MANY articles, giving data for the construction of an *electroscope*, have appeared from time to time in the various magazines devoted to popular science. The writers, however, seem to have given their attention to the production of some supersensitive instrument, capable of detecting a more feeble charge than had previously been possible. Altho by far the most important modern application of the electroscope is in the study of radioactivity and ionization, no one seems to have made any attempt to produce a simple instrument adaptable to the new uses; if so, they have not publisht their ideas. Extreme delicacy, while of great value, is not such an important factor as proper design. The electroscope to be described was designed by the author in consequence of poor experimental results obtained with other types. The design is based upon the construction of Mme. Curie's electroscope with which she was able to detect a particle of radium weighing approximately one one-hundred-millionth the weight of a single human red-blood corpuscle! While the instrument to be described is not of such a pretentious character as the Curie electroscope, it will give excellent results in all but the most delicate of radioactive experiments.

Faraday showed that, due to electrostatic induction, the reading of any electroscope could not be considered as absolute unless it was inclosed in a grounded metallic container or unless the interior of its insulating walls was lined with a grounded coating of tinfoil or wire gauze. As structural difficulties preclude the use of wire gauze or tinfoil, the former method was adopted in this particular instrument.

A rectangular tin container, A, Fig. 1, measuring 2¾" x 4⅛" x 5¾", was secured in place of the usual glass flask. The dimensions need not be precisely the same as those given, but they should be as near as is applicable to any peculiar situation. A hole, 2 7/16" x 2⅛", C, Fig. 1, was cut in the face of the container 1¼" from its bottom. Four strips of tin ⅜" wide were cut the general shape as shown in K, Fig. 1, two 2 9/16" long and two 2¼" long, and bent V-shape along the dotted line shown in the drawing. These strips were then soldered along the edges of the window, B, Fig. 1, as a reinforcement to prevent warping. A piece of glass, D, 2¾" x 3⅞", was clampt over the window by means of the strips, E and F, and the four battery bolts, ⅜" long, G, H, I and J. The strips were made from ⅛" poplar, 5/16" wide and 3½" long, L, Fig. 1. A sectional view is shown at M. A ⅛" hole was drilled in the center of each side of the container ¼" from the top to accommodate the screws, holding the cover in place, P and O, Fig. 2. A binding post, W, was provided on one side 1½" from the bottom as a ground connection.

A piece of wood, O, Fig. 1 (N, Fig. 2), 4⅛" x 2¾", was cut from ½" poplar to form a cover for the container. A 1½" hole with its center located 1⅜" from one end was bored in the cover to allow for the insulation, M, Fig. 2.

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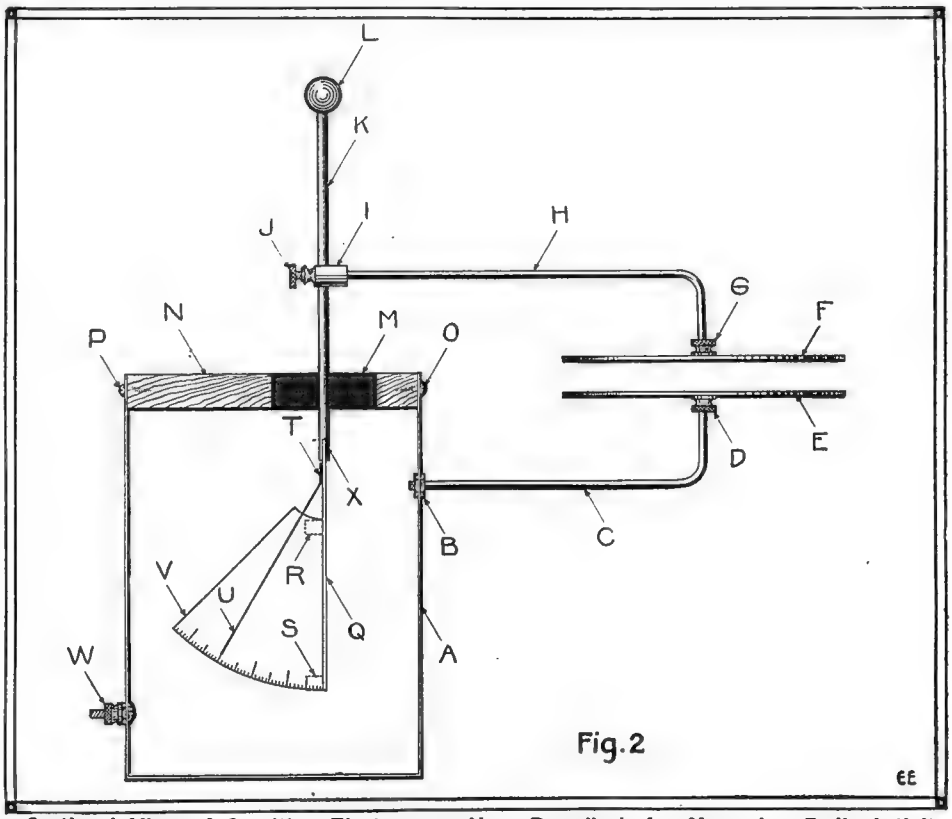


Sectional View of Sensitive Electroscope Here Described, for Measuring Radio-Activity. The Gold Leaf Rises or Falls in Front of a Finely Graduated Scale, Visible Thru a Window.

Silvering Mirrors

By D. McCLANAHAN

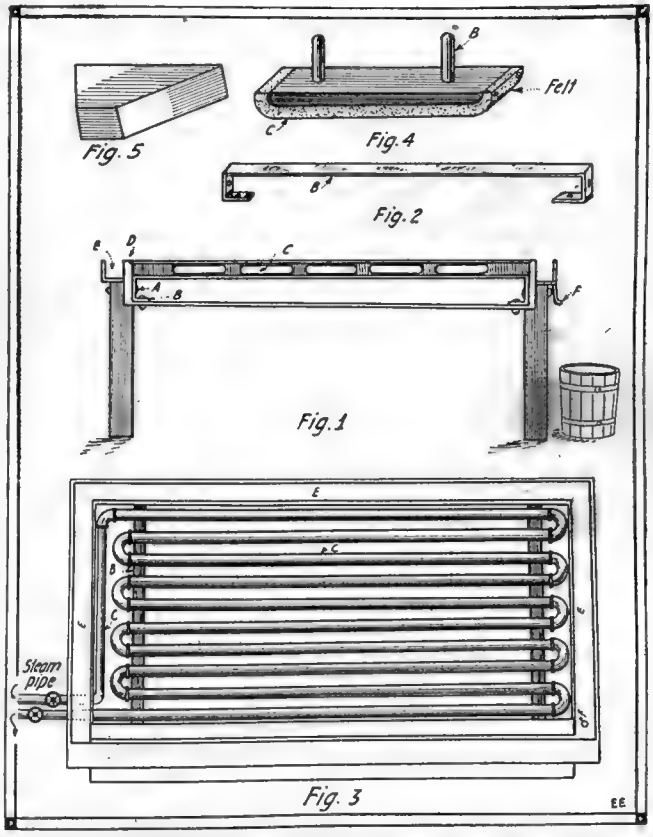
THE art of silvering mirrors has been held as a valuable trade secret for many years, but the formulas and instructions here given makes it possible for any one with ordinary care and a little patience to do the work successfully. I have endeavored to write these instructions in order that you may not become confused.

First you must have a clean room free from dust, in which place a steam table made as per instructions, tho this is not absolutely necessary, as you can warm the glass up to 80° to 100°. F. by pouring warm distilled water on the same. But for those who anticipate silvering mirrors to any extent a steam table will be found necessary. The size of the table I will leave to you, tho would suggest to make the table small, say three by six feet, until you become more proficient in the art.

Make a box three by six feet, open at the top; for legs use two by four timber. Bolt the legs to the box frame at A, Fig. 1. Next take a piece of iron three feet long, two inches wide and one-quarter inch thick, placing it across each end so the steam pipes may rest upon it, B, Figs. 1, 2, 3. This is to prevent the boards on the bottom of the table from burning. Place one-inch pipes in the table as in illustration, Fig. 3-C; on top of the pipes is placed an iron top, three by six feet and one-quarter inch thick. (Note.—It is best to go to a foundry and secure your iron plate first and build your frame work to fit the plate, for sometimes it is hard to get iron plate the exact size you want it.) This iron top must rest flush with the side boards D, Fig. 1. This is done by making a quarter-inch groove on all four sides of the table. Now cover the iron top with unbleached muslin, stretch and tack to the side boards.

Make a wooden gutter all around the table, E, Figs. 1 and 3, about three inches wide, and at F, Figs. 1 and 3, make a hole and place a spout in it. The table is connected to a steam boiler or hot water heater, using suitable valves V, V, as shown, to control the steam inlet and outlet pipes.

Do not attempt to handle a very large glass at first. One a foot square will be large enough to start with. Obtain a good grade of plate glass free from scratches. Next get some polishing rouge, which comes in powdered form. Place in a bag made of two or three thicknesses of cotton flannel, sew bag up, place in water to soak, then take the rouge bag and rub over the glass while the rouge is still wet; then rub well with your polisher, Fig. 4. This is a block of wood measuring six by three inches, having two handles for holders, B, Fig. 4, with a thick felt rubber attached at the bottom, C, Fig. 4. Keep the felt wet and proceed to polish the glass all over the surface that is to be silvered, being careful to polish right to the edges. When the rouge has dried, wipe it off. When thru polishing avoid touching the polished side with your fingers, as this would leave a grease spot and the silver would not adhere to the glass where you touched it. Put your hands under the glass and place it on your washing table and clean as follows:



With the Materials Indicated Above Anyone Can Make Remarkably Good Mirrors Which Will Compare Favorably With Those Now Being Sold. The Steam-Heated Table Insures Absolute Evenness of Coating, Which Is Brilliant and Durable.

Washing Solution.

Take one-fourth ounce of muriate of tin crystals to ten ounces of water, and from this solution take one ounce and add it to one pint of water. This one pint of water should look a very light blue in color. Now pour on the glass and rub off with a felt block like Fig. 4, but minus the handles.

Be sure to rub only one way, then pour on a lot of hydrant water, rubbing it off with another felt block. Place your hands under the glass and put it on the steam table, which has been previously warmed up to 90° to 100° F. Keep the side to be silvered up. Now level the glass by placing wooden wedges, see Fig. 5, under the edges. Pour warm *distilled* water on the glass in the same manner as the silver solution will later be poured on.

By pouring distilled water on glass and placing wedges as may be needed you can level the glass until you have an even layer of water standing all over it. Should the distilled water be slow in covering the edges, take your glass rod and draw the water by scraping along the edges. When you get the glass level, raise one side slightly and let all the distilled water run off, laying the glass back in place gently, being very careful not to displace the wedges, thereby making the glass unlevel.

How to Silver.

Pour your silver solutions No. 1 and No. 2 into a glass or stone pitcher, using the exact proportions as given in the formula below, stirring the solutions with a glass rod or by pouring from one pitcher to another. Now pour into the center of the glass without stopping as the precipitation commences at once, or as soon as the solutions are mixed.

Let the solution flow out until the entire surface is covered, allowing it to stand thirty or forty minutes to precipitate, then tip the glass on one corner, allowing all the solution that will to run off.

Next clean by pouring on the luke-warm distilled water, place the glass back on the wooden wedges for a few minutes to dry. When dry coat the side that is silvered with a mixture of *orange shellac*—two ounces; wood alcohol, one pint; turpentine six ounces. Use a camel's hair brush to smooth it out—after this is dry, paint over with a camel's hair brush and some *asphaltum varnish.*

The Boiled or Cold Process

Solution No. 1—Take 150 grains of nitrate of silver. $AgNO_3$, crystallized salt C. P., dissolve in 1 pint of distilled water and to this add with a glass eye-dropper concentrated or 26% ammonia, one drop at a time, until it turns dark—keep on dropping the ammonia until it turns light again—then put in 130 grains more of silver, $AgNO_3$ and let it dissolve—now pour this into 3 pints of distilled water first measured out. Have a ribbed funnel and in the neck of same press a little absorbent cotton before you put in the filtering paper—now put in the ribbed funnel two sheets of filtering paper and filter the solution—it is then ready for use.

Solution No. 2—Take 96 grains of crystallized Rochelle salts, place in one-half gallon of warm distilled water, using a porcelain lined vessel. Let this come to a strong boil for about two minutes, then add 96 grains more of $AgNO_3$ and let it boil for six minutes longer. As soon as this solution is cool, it is best to pour it from the porcelain vessel in which it was boiled into some glass vessel, as the vessel that you boiled this solution in will be quite dirty. Filter this solution the same as you did solution No. 1—into a separate pitcher—when ready to silver mix the two and flow on the glass. Let stand for 15 or 20 minutes.

The Caustic Potash Process.

Solution No. 1—Take 3 pints of distilled water—measure from this amount 4 ounces and add to the four ounces of distilled water 240 grains of $AgNO_3$—let dissolve—then take concentrated or 26% ammonia, 3½ drachms and add it drop by drop until the sediment is nearly redissolved then add the balance of the water—let this stand 12 hours and filter.

Solution No. 2—Take 48 ounces of distilled water and divide into 3 parts and add to the first part 180 grains of $AgNO_3$—add to the second part 20 grains of caustic potash—add to the third part 1¾ ounces of crystal Rochelle salt C. P.

Mix all three—shake well and let stand for 12 hours and filter. To use, mix 4 parts of Solution No. 1 and 1 part of Solution No. 2—stir with a glass rod and pour on glass at once—allowing 35 to 40 minutes to precipitate.

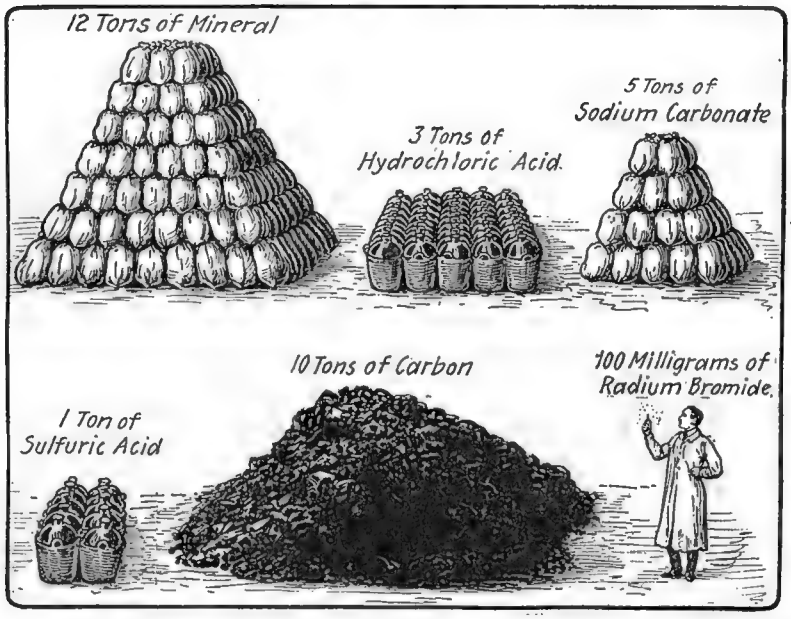
The French or Tartaric Acid Process.

Solution No. 1—Take 8 ounces of $AgNO_3$, dissolve in 8 ounces of concen-

(*Continued on page* 1219)

Radium--The Wonder-Substance

By HAROLD F. RICHARDS, A. M.


12 Tons of Mineral
5 Tons of Sodium Carbonate
3 Tons of Hydrochloric Acid
10 Tons of Carbon
100 Milligrams of Radium Bromide
1 Ton of Sulfuric Acid

How Radium Is Made: The Illustration Herewith Shows Graphically the Enormous Amount of Material Required to Make One Hundred Milligrams of Radium Bromide, a Quantity So Small That It Will Not Cover More Than a Large Pin Head. It Will Be Noted That Twelve Tons of Mineral or About 280 Sacks Are Required. Further, We Need Three Tons of Hydrochloric Acid, Five Tons of Sodium Carbonate, One Ton of Sulfuric Acid and Ten Tons of Carbon for the Apparatus. In Addition to This It Takes over One Month and 500 Successive Crystallizations In Working the Material Itself, a Great Many Workmen Being Required To Do This.

THE RADIUM STOVE.

DO you want a small lump of fuel which will heat your home for thousands of years, *requiring absolutely no attention or replenishing?* Fires go out, hot water cools, ice melts, but a gram of radium keeps constantly from eight to ten degrees hotter than its surroundings. A small thimbleful of radium generates in twenty-six days enough heat to raise a pint of water from freezing to boiling. In winter the average six-room furnace-heated home requires two tons of coal per month. One cubic foot of radium would take the place of this amount of coal, and centuries would pass before the rate of heating diminished appreciably. In 1,000 years this fireless stove would give the heat-equivalent of 20,000 tons of coal.

Not only would the stove require no attention for centuries, but there are no known methods by which its activity could be altered or regulated. We can hammer the radium into powder, cover it with lead, dissolve it in acid, heat it, freeze it, melt it, but none of these operations interferes in the slightest degree with its activity. It is, in the present state of our knowledge, as far beyond our conrol as the planets revolving in the heavens.

There are several obstacles in the way of a general adoption of radium as fuel. The rays from such a quantity of radium would kill a man in short order, unless the stove were surrounded by a case of lead a foot thick. Furthermore, not enough of the precious substance has so far been extracted from the earth to provide even *one* such stove. And even if there were a sufficient quantity, it would cost, at the present rate, over seven billions of dollars. So the coal merchants need fear no sudden competition from these automatic, foolproof, fuelless stoves.

HOW RADIUM IS MADE

The illustration above from *La Nature,* Paris, shows graphically the enormous amount of material required to make one hundred milligrams of *Radium bromide,* a quantity so small that it will not cover more than a large pin head. It will be noted that twelve tons of mineral or about 280 sacks are required. Further, we need three tons of hydrochloric acid, 5 tons of sodium carbonate, 1 ton of sulfuric acid, and 10 tons of carbon for the apparatus. In addition to this, it takes over one month and 500 successive crystallizations in working the material itself, a great many workmen being required to do this delicate and tedious work.

Fig. 1 Shows a Radium Photograph, the Radium Rays Recording the Different Densities and Depths of Material Traversed. During the Five Hour Exposure, There Is Much Production of Secondary Rays Which Cause the Outlines to be Somewhat Blurred.

A MODERN PHILOSOPHER'S STONE.

The old alchemist didn't worry about the conservation of matter or the law of cause and effect. He thought he had the ultimate by the horns, and patiently boiled sulphur, mercury, perspiration and toads' legs, confident that sooner or later he would produce the "magic stone" which would transform lead into gold. But he never succeeded, and the scientists who followed indulged in many a laugh at the alchemist who thought it possible to turn lead into gold.

But in 1896 science suffered as thrilling a shock as if a descendant of old Petrus Peregrinus had announced the discovery of the proper bath for changing the basest of all metals into gleaming gold. Up to that time the scientists had been patting themselves on the back, supremely confident that they had diagnosed Mother Nature's case so completely that she could never again produce any startling innovations. Yet here was radium, an element thousands of times as precious as the golden goal of the alchemists, spontaneously *changing itself into lead.*

In performing this startling reversal of the alchemist's dream, radium revealed a whole world of complex actions going on within the atom itself, which had long been considered the simplest unit of matter. Scientists were thus forced to reconstruct most of their ideas regarding the constitution of matter. In the light of the new knowledge presented by radium it was apparent that, to a minute creature of a size comparable to that of an atom, every atom of matter would seem as complex a world as the whole universe appears to us.

Before we consider the astonishing actions of this wonder-substance, let us take just a glance at its production. Pure radium is a silvery metal, but it is usually extracted in the form of radium bromid or chlorid, which are white salts. Twenty tons of the richest pitchblende would yield a small thimbleful of radium. Radium costs approximately 300 times as much as a diamond.

ELECTROSCOPE MEASURES PENETRATING POWER OF RADIUM RAYS.

The characteristic and indeed the most wonderful property of radium is its ability to emit continuously a spontaneous radiation capable of penetrating solid bodies thru which light cannot pass. It was this phenomenon which led to the discovery of radium. These rays are of two kinds, one being waves in the ether, an invisible light similar to X-rays, while the other consists of minute particles of matter actually shot off by the radium. The atoms of radium are continually exploding, and every second a thimbleful of the substance shoots out more bullets than there were dollars in the Victory Loan, yet the particles are so small that the thimbleful can continue to do this for 2,000 years and there will still be half a thimbleful left.

Both the corpuscular and the etherial radiations affect a photographic plate, and pictures are produced similar to those

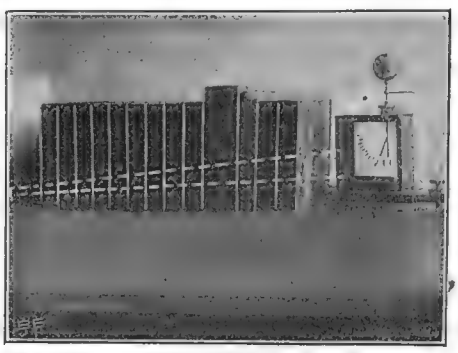


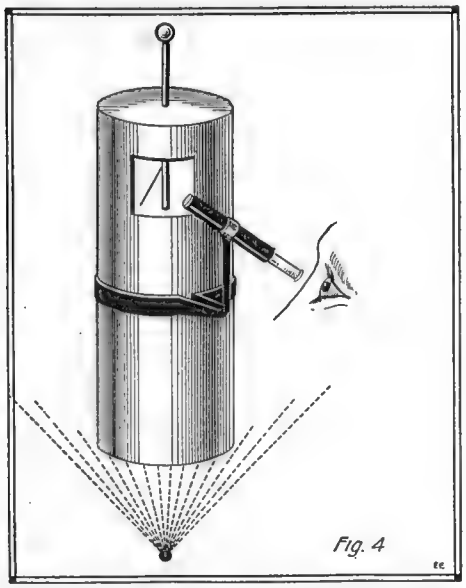
Fig. 1-A—A Remarkable Demonstration of the Penetrating Power of Radium Rays. In An Actual Experiment, a Charged Electroscope was Affected by Rays From a Radio-Active Substance After Penetrating Two Feet of Wooden Blocks, As Shown Here.

made with X-rays. See illustration, Fig. 1. The rays are directed thru the object, and the shadows on the plate are due to the different densities of matter traversed. But the most interesting experiments with radium are performed with an *electroscope*. This instrument operates by virtue of the *ionizing power* of the radiations. In passing thru air, the rays cause gas molecules to break up into negatively-charged electrons and atomic residues bearing positive charges. The electroscope consists of a metal rod to which one end of a gold leaf is attached. When rod and leaf are charged, electric repulsion causes the leaf to stand extended away from the rod. If the gas surrounding a positively-charged electroscope is ionized, the ions bearing negative charges are attracted to the rod, and there neutralize some of the electricity on leaf and rod. This causes the leaf to fall, and the *rate of collapse* is a measure of the intensity of the rays entering the vessel.

The penetrating power of the rays can readily be measured with such an instrument. The radiation passes thru the absorbing material before entering the electroscope, and the rate of fall of the gold leaf is measured by means of a telescope provided with a scale. The instrument can be made so sensitive that it will detect *gamma* rays after they have penetrated *three feet of hard maple wood* or *one foot of iron*. See Fig. 1A. This *gamma radiation* consists of ether vibrations. The electrons shot from radium are termed *beta* rays, and the atoms spontaneously expelled are called *alpha* rays. The latter can penetrate a few inches of air or a sheet of writing paper, while the electrons are able to go thru half an inch of wood.

MEASURING THE ELECTRICITY ON RADIUM PROJECTILES.

In an interesting experiment it is possible to measure the electric charge carried by the material bullets shot from radium. These have the property of causing a flash of light upon striking certain substances, such as diamond or zinc-sulfid. The radium is enclosed in a heavy lead box with a tiny hole, so that only as many rays emerge as can be counted. A plate of zinc-sulfid receives the rays, and by counting the sparks the number of particles can be estimated. See Fig. 2. The quantity of electricity received by the plate is measured, and from this data the charge carried by one particle can be determined. It is not a large quantity. The number of drops of water required to fill sixty railroad tank cars is the number of these particles that would be necessary to carry enough electricity to keep an ordinary sixteen-candle power electric lamp lighted for one minute.



Special Form of Sensitive Electroscope Used In Detecting Lost Radium, as for Instance Radium Which May Have Dropt on the Floor of a Laboratory or Room and Which Cannot Be Seen With the Unaided Eye. This Electroscope Has Lead Side-Walls and Top, But Is Open at the Bottom. When It Happens To Be Held Over the Radium, the Gold Leaf Will Fall Sharply as Soon as It Is Directly Above the Precious Substance.

SPEED OF THE RAYS.

The velocity with which the radium radiation travels is enormous. The *gamma* rays move at the same rate as light and the waves of wireless telegraphy, namely 186,000 miles per second. This is fast enough to encircle the earth 444 *times in one minute*. Even the material particles are shot from radium with unthinkable speed. The *alpha* rays, each one of which is a positively-charged atom of radium, minus one electron, have a speed 3,000 times as great as the muzzle-velocity of the shells thrown by the long-range guns in bombarding Paris. The fast-moving electrons, or *beta* rays, nearly approach the speed of light, or 30,000 times the velocity due to the giant guns. These electrons are exactly the same as those which produce X-rays by their collisions with the metal target in a Coolidge tube, and it is to their free motion in metals that the conduction of current in wires is attributed. In fact, the more radical of present-day physicists assert that all matter is essentially *electronic*, and *that electricity is the foundation of the MATERIAL world*. The isolation of electrons from radium and the measurement of their mass, charge and velocity were largely responsible for the overthrow of 19th century ideas regarding electricity and the constitution of matter.

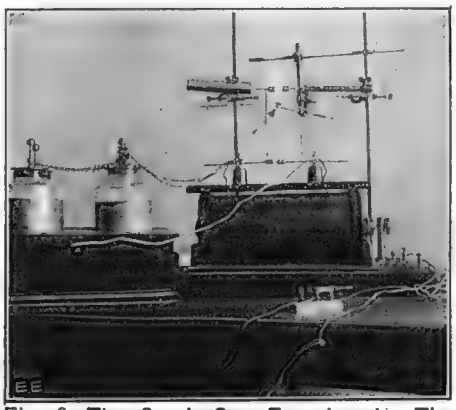


Fig. 3—The Spark Gap Experiment. The Ionization Caused by Radium Brought Near the Longer Spark Gap Just Above the Short One on the Spark Coil Causes the Spark to Jump Across It. The Spark From a Leyden Jar Battery Is Used. The Short Gap Is Protected From the Radium Rays By the Lead Disc on Which the Radium Rests.

THE SPARK GAP EXPERIMENT.

One of the most spectacular experiments with radium is that of the *spark gap*. The high tension terminals of an induction coil are connected to two spark gaps. One gap is longer than the other, and the spark chooses the shorter one. Electricity, like many human beings, prefers the path of *least resistance*. But if the rays from radium are directed toward the silent gap, the spark will leave the other path and crash across the gap near the radium. In this way the silent gap can be made to respond instantly to the invisible power of the speck of wonder-substance. This is because the ions produced by the radium decrease the resistance of the air between the spark terminals. The smooth balls are used instead of spark points in order to stabilize the phenomenon. See Fig. 3.

The writer has also performed this experiment with a single gap to which is connected a battery of Leyden jars. The spark electrodes are drawn apart so that the coil is silent. The radium is brought near, and a tremendous crash is produced! The large quantity of high tension electricity stored in the Leyden jars is released by the radiumionized gap, with a noise like that of a high-powered radio transmitting station.

FINDING LOST RADIUM.

Radium is commonly employed in the form of a tiny speck of its bromid salt,

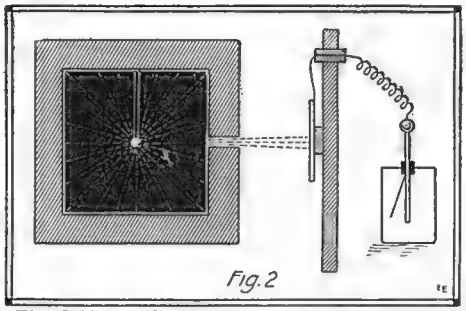


Fig. 2 Shows Apparatus Used In Determining the Electric Charge Carried by the Particles Shot Off From Radium. These Particles Have the Property of Causing a Flash Against a Zinc Sulfid Solution When They Strike. By Counting the Sparks the Number of Particles Shot Forth and the Charge Can Be Readily Estimated.

enclosed in a glass capsule. Inasmuch as even $500 worth, if dropt on the floor, can hardly be seen with the unaided eye, much trouble has been caused by such accidents. In some instances large sections of flooring have been removed and reduced to ashes, so that the lost radium could be recovered by electrical and chemical means. If the approximate locality in which the loss occurred is known, a specially constructed electroscope will indicate the spot where the radium lies. The electroscope is made with a long, cylindrical body, the sides of which are protected with heavy lead. Virtually all the ionization in such an instrument must be caused by rays coming directly thru the unprotected lower end. See Fig. 4. If this apparatus is carried about over the region where the radium is supposed to have been lost, the gold leaf will fall sharply when directly above the radium.

WHAT BECOMES OF RADIUM?

Since radium is constantly shooting itself away, one asks what becomes of it? The *alpha* rays eventually lose their electrical charge and become atoms of helium, which is one of the rare components of the atmosphere. Radium also gives off another gas, called *radium emanation*. This emanation has been condensed into a yellow fluid, and is itself radioactive, eventually turning into *helium*. But more remarkable still, radium itself, after radiating particles for thousands of years, *turns into lead!* Thus the most costly metal changes into one of the basest, and the golden dream of the alchemist is reversed. But it is the wonderful energy of radium which distinguishes it from common substances, and this energy has been largely expended before the radium becomes lead.

RADIUM REVEALS THE AGE OF THE EARTH.

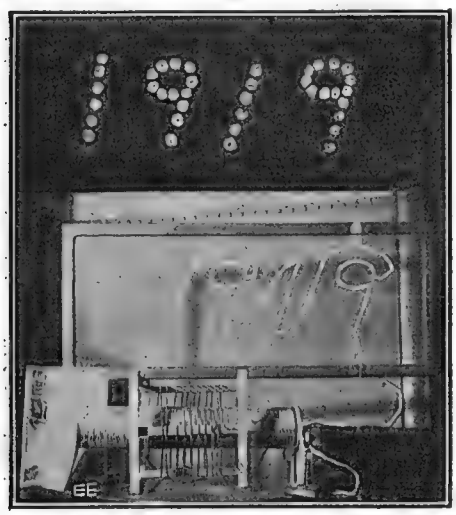
It is definitely known how much helium will be evolved in a given time by a quantity of radium. Some deposits of radioactive material have been found in rocky cavities, entirely enclosed in metal ore, so that the gas has no opportunity of escaping. In such cases it is comparatively easy to measure the amounts of radium and helium present, and the time for the radium to liberate that quantity of gas can be calculated. Undoubtedly the radium has been in the ground since the formation of the earth's crust, so that the age of the earth can be deduced. Various such measurements made in different parts of the world indicate that the earth is at least 230 million years old. This agrees very well with the figure given by Sir William Thomson, who, by calculations based upon the known cooling of the earth, estimates that it is 200 million years since the earth was a molten mass.

NOVEL ELECTRIC SPARK SIGN.

High-frequency experiments are always interesting and the one shown here and described below is one of the most entertaining that could be prepared for any audience. This experiment can be called "The Electric Spark Sign," and a study of the pictures will show how it is constructed. The apparatus needed is a transformer (or spark coil), a condenser and a Tesla coil. The operation of the sign is as follows:

The 110-V. current is stept up to a very high potential in the secondary of the Tesla coil. The discharge takes place across small air gaps which form the outline of the letters.

The sign is constructed as follows: A large sheet of glass 2×4 feet is secured. This can generally be found by a visit to the family bookcase. The letters, which are made of tinfoil, are placed on this glass. Strips of tinfoil ¼ inch wide and 10 inches long are cut. These strips are carefully glued to the glass in such a position as to form the letters required. These letters should be at least 8 inches high, and should be sufficiently separated from one another to prevent sparks jumping across instead of following the proper path. As is seen in the picture, a piece of tinfoil connects the end of one letter with the beginning of the next. Another strip of tinfoil is fastened to the beginning of the first letter; this leads to a binding post in the frame. A similar piece connects the end of the last letter to another binding post. Small



Upper Photo Shows Appearance of Mystical Electric Spark Sign Illuminated In the Dark. Lower Photo Shows Tesla Coil Connected to Tin-Foil Letters.

air gaps must now be made in the tinfoil strips that form the letters. With a safety razor blade gently part the tinfoil at these places and roll back one end of the tinfoil, about 1/32 inch. (If this space is found to be too small for the spark, it can be widened.) When a sufficient number of these gaps are made, the sign is complete.

The transformer and Tesla coil is connected as usual; two wires lead from the Tesla secondary to the two binding posts on the frame of the glass. When the transformer is started in a dark room and the primary of the Tesla tuned correctly a heavy discharge will flash across each air gap with a purplish-white flame.

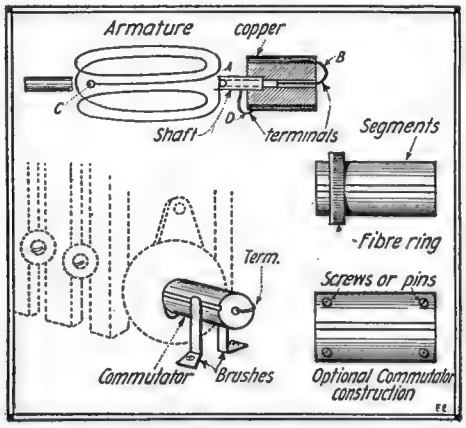
At a New Year's Eve party, a novel effect was secured by the use of this spark sign. The numerals 1919, in tinfoil, were glued to the glass and at midnight the sign was started. The numerals 20 were placed behind the 19 on a second glass sheet; by quickly changing the connections the year was mysteriously rearranged from 1919 to 1920.

The photographs show, first, a flashlight of the apparatus connected and operating; second, how the sign looked in the dark.

Contributed by E. C. FEWELL.

BATTERY MOTOR FROM METER.

Since I began experimenting I have owned a telephone ringing Magneto Generator. It delivered a strong *high voltage*



Here's How To Make a Battery Motor or D. C. Dynamo From a Telephone Magneto. A Commutator Is Required, But Its Construction, With But Two Segments, Is Very Simple.

alternating current which was of very little use to me. But I have devised a simple way of transforming it into a powerful battery motor, which will run at high speed with three cells and when used as a dynamo will supply sufficient direct current for lighting small electric lamps, motors, bells, etc. As seen in the illustration the apparatus consists of a *two-sector commutator* which was made as follows:

To the surface of a thread spool deprived of the flanges were glued two thin copper plates, equal in length and separated from each other about 1/16 of an inch.

To the end of the armature shaft were soldered two pieces of copper wire of about two inches, then the commutator was slipt thru the center one and glued to the end of the shaft, the connections being made as shown in the diagram, where AB and CD represent the two terminals of the armature windings.

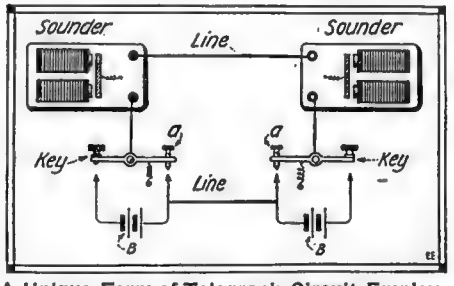
The motor was mounted on a wooden base and the two copper brushes fixt as shown. The armature winding was removed and the fine wire was changed for number 20 single cotton covered copper wire. As a dynamo the voltage will be reduced from 110 or 150 to 8 or 10 volts, with ⅛ to ⅙ ampere of current. About the same potential is required to operate it from batteries.

Contributed by JOSÉ VELARCO, JR.

A DRY CELL TELEGRAPH LINE.

One terminal of the sounder must be connected to the lever of the key and the key must have two points. The adjustment screw may make contact with the extra point, which may be fastened to base of the key. If the adjustment screw strikes metal the extra point may be made of a strip of brass fastened to the wood base and bent up over the metal base.

Contributed by W. LEE DORN.



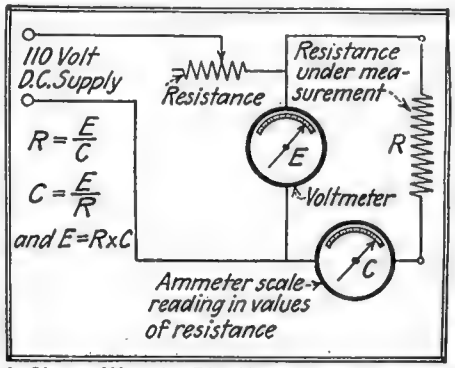
A Unique Form of Telegraph Circuit Employing Dry Cells Instead of a Gravity Battery at Either End of the Line.

A DIRECT READING RESISTANCE MAGNETO.

An ordinary voltmeter and ammeter are connected in series with the source of supply in order that a definite amount of voltage (110 volts in this case) may be maintained at all times.

The ammeter described is one with a scale of 0.3 ampere, the scale being calibrated to read in tenths. The following readings are herewith given for the convenience of those who wish to use the same size ammeter:

Amperes in tenths	Resistance in ohms
.1	1100.000
.2	550.000
.3	366.666
.4	275.000
.5	220.000
.6	183.333
.7	157.142
.8	137.500
.9	122.222
1.0	110.000
1.1	100.000
1.2	91.666
1.3	84.615
1.4	78,571
1.5	73.333
1.6	68.750
1.7	64.117
1.8	61.111
1.9	57.894
2.0	55.000
2.1	52.380
2.2	50.000
2.3	47.826



A Clever Way to Rig Up a Direct-Reading "Resistance Meter" By Means of a Voltmeter and an Ammeter, the Scales of the Latter Instrument Being Calibrated In Values of Resistance.

2.4	45.00
2.5	44.000
2.6	42.300
2.7	40.740
2.8	39.285
2.9	37.931
3.0	36.666

Should it be necessary to measure lower values of resistance more resistance can be inserted in the supply source, thereby lowering the voltage, but new values of resistance will have to be figured for a new scale. The main idea is to once plot the values of resistance and maintain the current supply at an exact value.

This method of measuring resistance is modeled after that followed in the electrical laboratory, employing two standard and accurately calibrated instruments such as a voltmeter and ammeter, which enable one to utilize the relations of Ohm's law to determine accurately the resistance of a certain coil. One very important factor, however, in such measurements at least where accuracy is demanded or required, is that the source of current shall be very constant. This is rarely so on ordinary 110-volt lighting or motor circuits, owing to the variations in potential on such systems, occasioned by variations in load, and the only really accurate and dependable source of current is a storage battery.

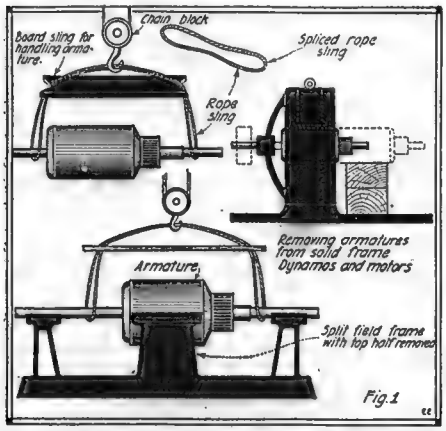
Contributed by E. T. JONES.

The Electrical Machinist

By H. WINFIELD SECOR

No. 5—PRACTICAL ARMATURE WORK, INCLUDING BANDING

IN the last paper we took up some of the machining operations on motor and dynamo field castings, and in the present paper we will take up some practical details of armature work, particularly that part of the work which usually



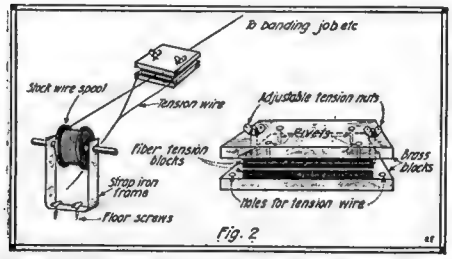
Lifting Armatures—Always Use a Board Cut to the Shape Shown So the Rope Can't Cut the Windings.

falls to the lot of the Electrical Machinist.

At Fig. 1, a few suggestions are shown for the handling of dynamo or motor armatures, as this is very important. An armature, no matter whether large or small, should never be set down on an ordinary floor, but should rest on a piece of cloth or burlap, and in many shops it is one of the ten commandments that an armature must not be laid down on its side or laminations, as, owing to the small width of the teeth, there is liable to be too much strain on them caused by the heavy weight of the armature and the teeth pushing into the winding, thus grounding or short-circuiting some of the turns composing them.

It is the best plan, therefore, to always place armatures on a rack suitably built for the purpose, or else on armature stands provided with roller or ball-bearings, such as that shown at Fig. 3.

In lifting the heavy armatures by means of a rope sling and chain block or other tackle, it is not sufficient that a substantial rope be used, but also it should be spread out on a wooden block or board having "V" notches cut in both ends as shown at Fig. 1. This is done to prevent the rope from bearing against the commutator or the armature coils, which would be liable to damage them both mechanically and electrically. It is easy to remove the armature from some machines, which have the top half of the field carcase or yoke split at the center, as in this case the top half of the circular field frame can be lifted off, also the top caps of the bearings, when the armature and shaft can be readily lifted out.



Detail of Tension Clamp for Armature Banding Wire. It Is Adjustable Yet Simple to Make.

Another detail shown at Fig. 1 is that of removing the armature from a solid frame machine, and this is always a difficult job to perform. Substantial wooden blocks or else a strong box is placed in front of the machine, after one of the end bearing frames has been removed, and the armature is generally lifted and moved out of the frame by two men, one stationed at either end of the armature shaft. Some burlap or padding should be placed on the blocking, so that the armature will not rest directly on the wood, and great care should be taken to see that no screws, metal cuttings or nails are on the surface where the armature is to rest, as this will be driven into the windings by the weight of the armature pressing upon them, and cause short-circuits, etc., in the windings.

DOLLARS FOR JOKES

A SCIENTIFIC magazine is supposedly notorious for its dry reading. Still we flatter ourselves that the ELECTRICAL EXPERIMENTER can hold your attention without your yawning too frequently.

Of course you like to laugh—we all do. Sometimes we make you smile while you peruse the EXPERIMENTER. Perhaps sometimes you laugh out loud—at some of our "preposterous ideas" which we print here. And then of course the joke's on us, because we were real serious!

Now it occurred to us that we would like to print a column of real, original jokes every month, but here's the hook: The joke must be a SCIENTIFIC JOKE. No, this is no joke, we mean it!

Anyone can print or re-print jokes, but we want them with a dose of science. So, till further notice we will pay $3.00 as a monthly 1st prize for the best joke, and $1.00 for each other one we print.

So you will know what we mean with a "Scientific Joke," we print one here, which we purloined from the "Baltimore American":

LOGICAL.—"I want some good current literature."
"Here are some books on electric lighting."

Now of course, our readers can do much better than this. So let's wait and see. One reader can submit as many jokes as he pleases. Even if it is old the joke is not necessarily barred or condemned. There is one rule however: The joke must not be too technical; in other words, it must be readily understood by anyone. Not more than 100 words can be used. Use only one side of the paper.

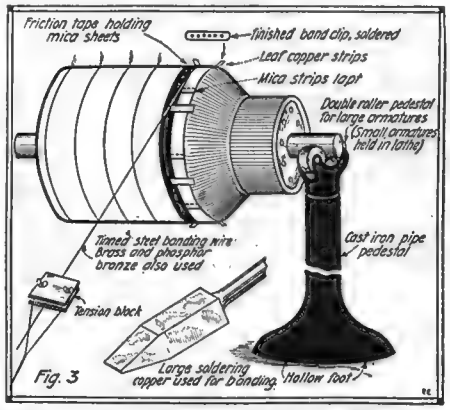
Address
SCIENTIFIC JOKE EDITOR,
Care of this publication.

BANDING WIRE TENSION CLAMP.

The winding of armatures hardly comes under the head of electrical machine work, so therefore this will not be touched upon except here and there in this series of papers.

One of the next important details which arrests our attention in the electrical machine shop routine is the *banding* of armatures. Before proceeding with the details of banding the windings, which work covers the winding around the exterior perifery of the core several bands of phosphor bronze or tinned steel wire, which serves to retain the armature coils within the slots, we will first take up the construction of a useful and substantial tension clamp for use in applying the banding wire.

As might be surmised, there is no use, and in fact great danger, in applying a loose wire band or bands on an armature, for it must be remembered at all times that the periferal speed of a spot on the surface of an armature to be used in an electric motor or dynamo is very high, and in no case is it less than several thousand feet per minute. The consequence of a loose band or one improperly soldered and fastened is


Friction tape holding mica sheets
Finished band clip, soldered
Leaf copper strips
Mica strips lapt
Double roller pedestal for large armatures (Small armatures held in lathe)
Tinned steel banding wire brass and phosphor bronze also used
Cast iron pipe pedestal
Tension block
Large soldering copper used for banding
Hollow foot
Fig. 3

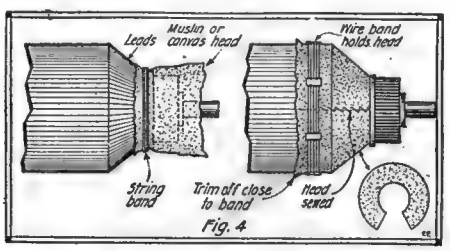
Banding Armatures—The Full Details Are Explained in This Paper. A Mean But Necessary Job.

likely to be a damaged armature, and the writer has seen accidents of this kind which have not only destroyed the electrical winding on the armature but have very badly damaged the core teeth, not to mention the "fireworks" displayed when the affair took place—all this trouble being caused by a loose band becoming displaced so as to be caught between the whirling armature and the field pole-pieces.

The tension block shown at figure 2 is therefore a very important piece of apparatus. It is usually made by the electrical machinist and electrician, with brass and fiber for the top and bottom clamping plates, or these can be made of iron, etc. Brass has the advantage that it will not rust, and is therefore the more desirable for the top and bottom members. Between the two metal plates there are placed two fiber compression blocks, between which the banding wire passes, and the tension on which blocks may be regulated to any pressure desired by simply screwing down on the two thumbnuts on the bolts passing thru the two sides of the tension block. Two holes are drilled in the rear corners of the tension block base, in the manner shown, to which a wire saddle is attached, and this leads down to a screw eye fastened to the floor. The banding wire, which may be of tinned steel, plain or tinned phosphor bronze, or sometimes hard brass wire, and which comes wound on a stock spool, is held on a metal rod or piece of pipe in some form of frame or saddle in the manner illustrated at Fig. 2.

A very good support for this spool of wire can be formed from a piece of flat

(*Continued on page* 1180)



Heading Up Armatures. It's Done With a Piece of Cloth Cut to the Shape Shown At the Right, the Bands Holding It In Place.

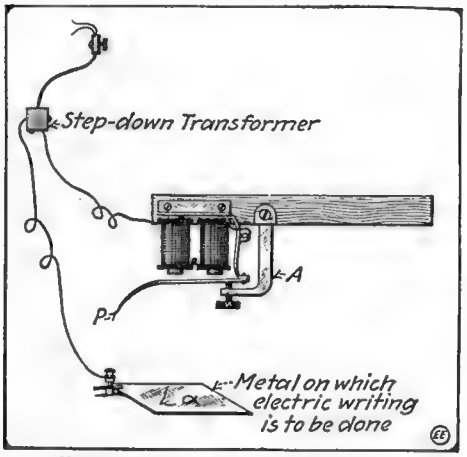
HOW-TO-MAKE-IT

This department will award the following monthly prizes: First Prize, $3.00; Second Prize, $2.00; Third Prize, $1.00.
The purpose of this department is to stimulate experimenters towards accomplishing new things with old apparatus or old material, and for the most useful, practical and original idea submitted to the Editors of this department, a monthly series of prizes will be awarded. For the best idea submitted a prize of $3.00 is awarded; for the second best idea a $2.00 prize, and for the third best prize of $1.00. The article need not be very elaborate, and rough sketches are sufficient. We will make the mechanical drawings. Use only one side of sheet. Make sketches on separate sheets.

FIRST PRIZE, $3.00

ELECTRIC PEN.

The diagram shows an electric pen which can be made in a few minutes. This instrument is very useful for marking tools, etc. It is run by a small step-down transformer, such as one used for operating toy trains. The coils and armature of an old bell are removed from the iron base and



Easily Made Electric Etching Pen.

mounted on a piece of board about ten inches long and three-quarter inches wide. The hammer is filed off and end of armature is bent as in sketch. The contact maker is also filed off and a regulator A is put on in its place.

To write, the pen is grasped by handle and point P is brought into contact with metal to be written upon. As soon as the contact is made an action similar to that of an electric bell is set up.

The writer's pen works best on eleven volts, but of course the current required is determined by the coils used.

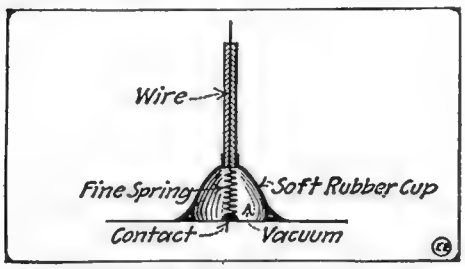
(*Editorial Note.*—The contributor submitted an excellent sample of this electric etching on a silver watch case.)

Contributed by G. BOUCHER.

VACUUM CUP CONTACT.

This device could be used instead of unsightly binding posts on wireless sets; also instead of cord tips on telephone receivers as well as on condenser surfaces, experimental circuits, etc. The rubber cup is wet, if necessary, before being pusht tightly against the metal surface.

Contributed by EDWARD STANKO.



Quick-Acting Suction Cup Contact.

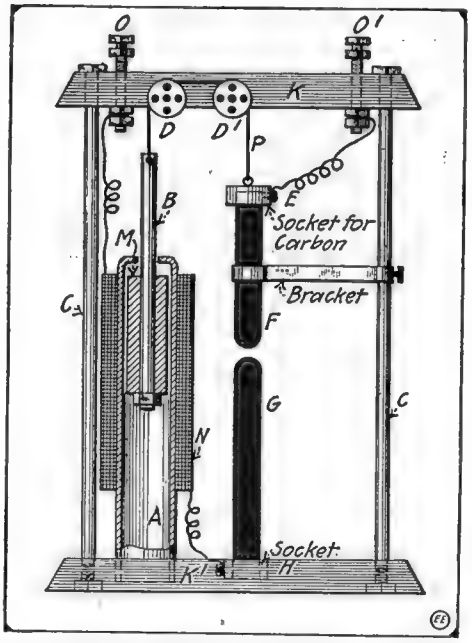
SECOND PRIZE, $2.00

NEW TYPE EXPERIMENTAL ARC LAMP.

A very interesting arc lamp may be made in the following manner: First we must obtain an old bicycle pump. Then remove rubber hose and bottom, leaving piston and cylinder. When this is completed, cut cylinder (A) and piston (B) in half, drill small hole at end of piston (B) and then wind (A) with four layers of No. 18 annunciator wire as shown in diagram (N).

Fibre bushing (M) is placed between (A) and (B) in order to keep (B) in the center. A hole is drilled in wooden block (K') so that coil (A) shall stand firmly perpendicular to it. After this is completed, erect two pulleys as shown in diagram and prolong a soft wire from piston over pulleys to socket for carbon and then fasten. The socket (H) should be countersunk as shown, with its lower carbon placed as shown in diagram. The connections for wires are shown in the sketch and the binding posts are O and O¹. Lamp can be regulated by adding or decreasing weight at carbon end and can be operated on 40 to 50 volts, direct current.

Contributed by JACOB KEENER.



Home-Made Electric Arc Lamp Made Partly From an Old Bicycle Pump, and Other Odds and Ends Found About the Experimenter's "Lab."

"HAIR ELECTRICITY" LIGHTS GEISSLER TUBE.

If a hard rubber comb, which has been electrified by running it thru the hair, is presented to the terminal of a Geissler tube, the effect of the discharge can plainly be seen. Needless to say, this experiment must be performed in the dark.

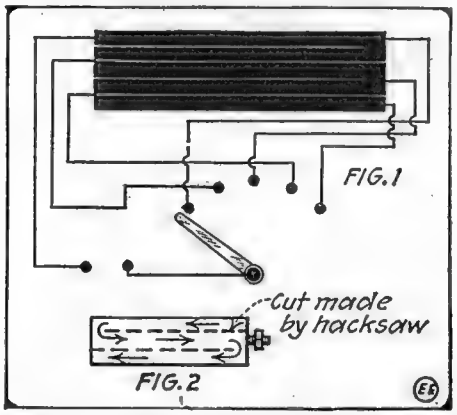
Contributed by FRED FLOYD, JR.

THIRD PRIZE, $1.00

RHEOSTAT FROM BATTERY CARBONS.

Herewith is a diagram of a small rheostat. It can be made of one or more old battery carbons if desired. In Fig. 1 the white spaces are simply slits made in the carbon by a hack-saw. In Fig. 2 the arrows show the course taken by the current.

Contributed by WM. ATKINSON.



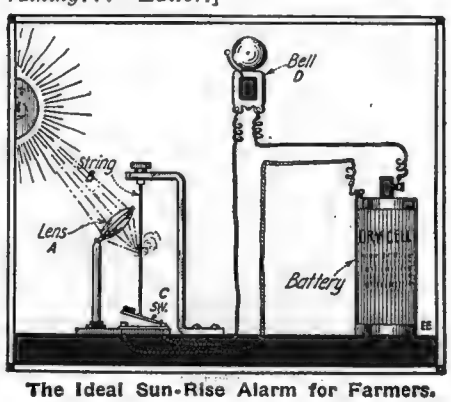
Rheostat Resistances Made From Battery Carbons.

FARMER'S ELECTRIC ALARM CLOCK.

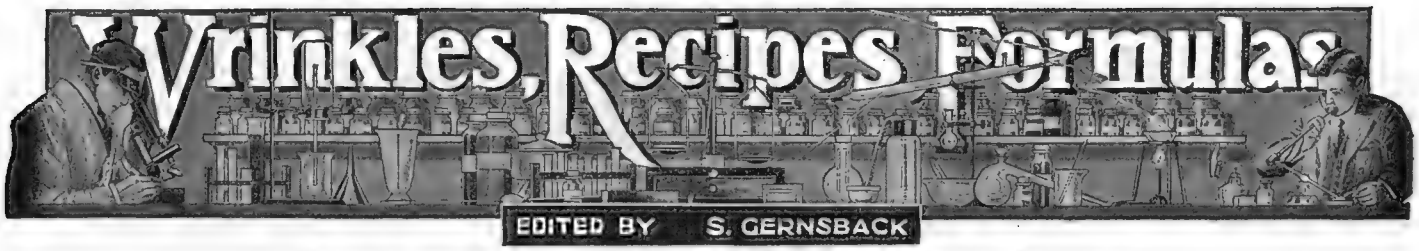
Rising sun shines through sun glass (A), which is focused on thread (B), causing thread to burn. This released metal spring (C), closing circuit and ringing bell (D). Farmer gets up and goes to work. On rainy mornings the alarm will not ring, thus allowing the farmer to sleep as long as he pleases. The inclement weather would prevent his working if he did get up early.

Contributed by ALTON D. SPENCER.

[*Wal, I'll be horn-swoggled and be dinged, if thar ain't a purty fine idea. But, Gosh all hemlock, Alton, me boy, you furgit that thar "Daylight Savin'" statuty. When it's 5 o'clock now it's only 4 o'clock, and the sun hain't ris yet, dadgast their buttons! P. S. 2—Aside from the above, WHO will focus the lens exactly every morning, and, alas and alack—suppose it's cloudy or it's raining???—Editor.*]



The Ideal Sun-Rise Alarm for Farmers.



Improved Fireless Cooker

A cooking utensil designed to take the place of a fireless cooker is described herewith:

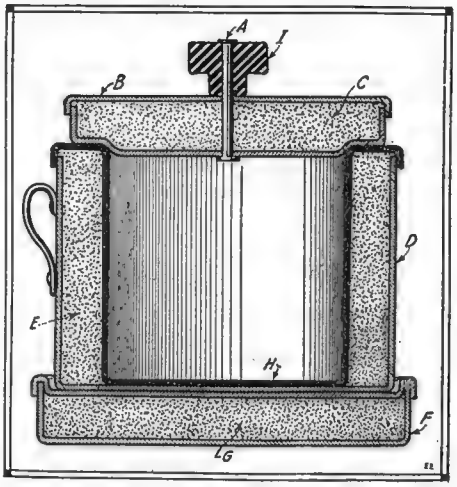
It is composed of a cover "B," body "E" and base "F." The ordinary fireless cooker" is bulky, taking up often valuable space in the kitchen whether in use or not. Second it is an expensive article to buy. Third—being difficult to keep clean, unless extraordinary care is taken it is liable to smell sour.

The device here submitted can be made at a fraction of the cost of the ordinary cooker.

It can be handled, washed and put away like any other cooking utensil.

It might be well to say a word concerning its construction and method of using it.

The cover "B" has a handle I and an air vent A. The walls are of aluminum and the packing, mineral wool. Mineral wool is a cheap non-inflammable non-conductor of heat. The body and base are of the same material and all three pieces should have packing of about one and one-half inches thickness. The wool should not be packed in tightly. No mineral wool is shown at bottom but rather a double aluminum bottom "H."



The Advantages of This Fireless Cooker Are Self-Evident. Very Practical and Cheap.

In using the body with cover in place is placed upon the heater and contents brought to a boil. This is accomplished with a minimum amount of heat as there is no loss of heat through radiation from walls and cover.

Then it is lifted from fire to base and there it will continue to cook for hours if necessary.

The advantage of the fireless cooker, well known to many, are the saving of fuel, and the impossibility of burning the food. Thus one can set food on at night and it will be ready in the morning or the evening meal may be set to cook in the morning before going to business and be ready when one returns from work.

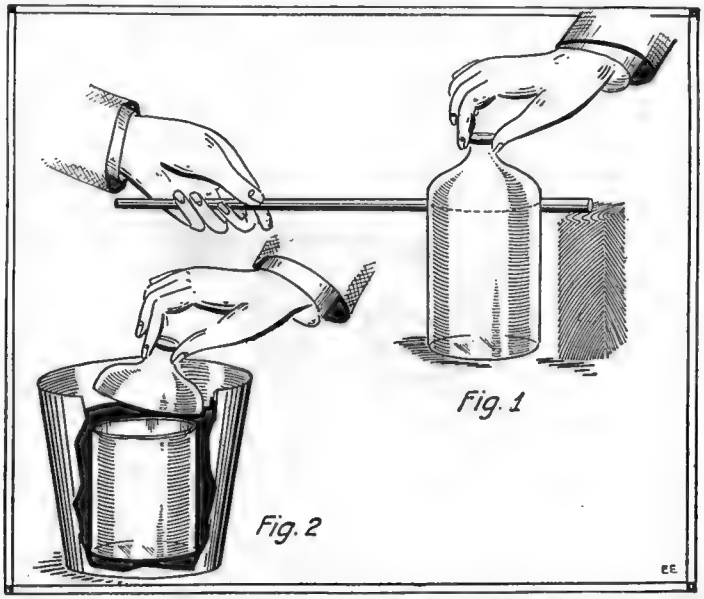
This would prove very handy for many who room in the large cities, working during the day and yet prefer doing some of their own cooking. Comparatively few people are awake to these advantages.

Contributed by JAMES MACINTYRE.

CUTTING GLASS BOTTLES.

It often happens that one desires to cut a glass bottle to make a battery jar or for whatever purpose, but there seems to be a common impression that it is difficult to do, while as a matter of fact it is exceedingly simple, and I have performed it many times and with good results.

All you need is to get a brick or some other non-inflammable substance of whatever height you wish to cut your jar. Next, place a heavy or preferably a short length of ½-inch iron rod, in the fire and heat about six inches of the end to a bright red heat. Then using the brick as a rest or guide, as in Fig. 1, turn the bottle slowly, keeping the red-hot bar well in contact with the bottle until the bar just ceases to be red. Then quickly plunge the bottle in a pail of cold water, and if carefully done a fine crack will be the result. The theory of this idea is that glass is a very poor conductor of heat, and as the bar touches the glass only a fine line all around the bottle, it will therefore only be heated in a fine ring around same and the rest remains comparatively cool. Upon plunging in the water a click will be heard and the neck and upper part of bottle will remain in your hand, Fig. 2, leaving an edge cut as clean as if cut with a glazier's diamond.



A New Bottle-Cutting Wrinkle! Iron Bar Should Be Provided With Handle.

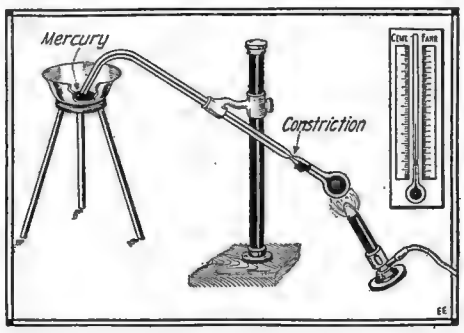
Another trick is to saturate a woolen string with turpentine and then set fire to it. The bottle is then plunged into cold water.

Contributed by
E. C. MEILLORET.

THERMOMETER FOR RECORDING MAXIMUM TEMPERATURE.

Secure an old thermometer and empty out the mercury. If you have not one on hand, a bulb can be blown on a piece of capillary tubing by heating the end in a Bunsen flame until it closes and then blowing gently into it, after removing it from the flame. Next heat the tube at a point about an inch from the bulb, revolving it slowly, and remove it from the flame when soft, still revolving it, draw it out carefully, so that the small inner bore of the tube is almost closed. (It must be less than half the original bore in order to function properly), and set it on an asbestos mat to cool. Now put about ten grams of mercury in a shallow evaporating dish and arrange the apparatus as shown in the figure.

When the tube has cooled it should be heated once more, near the top, and bent at an angle of about 90 degrees, then clamp it in the position shown with the open end dipping under the surface of the mercury. Heat the bulb gently and then allow it to cool. Atmospheric pressure will force some of the mercury into the bulb. Repeat this operation several times until the bulb is almost full. Then heat it strongly, but do not allow the mercury to boil, until the mercury expands and fills the tube, expelling all the air and leave it in position until the mercury has cooled to 100° Centigrade, when it should be quickly lifted from the dish and the end closed in the Bunsen flame before the mercury column recedes and allows any air to enter. After cooling it should be wired to a base and a scale attached which is marked by comparison with a standard thermometer. To reset it simply hold vertically and shake.



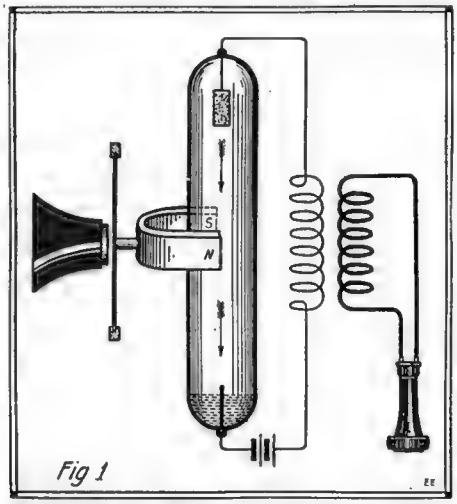
Contributed by A. K. LAING.

RADIO DEPARTMENT

Gaseous Telephone Transmitters

By RICHARD A. ENGLER

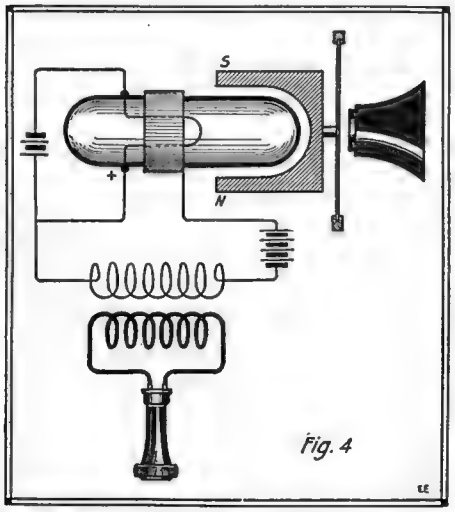
THE carbon or microphone transmitter, like all other good things, must give way to something better. History shall record the good deeds of the carbon transmitter, while the ones herein described have the stage.



Something Brand New in Telephone Transmitters—a Magnet Fastened to the Diafram Acts on an Ionic Stream and Causes Variations in It, as Well as the Current Traversing It.

Some of the reasons why the transmitters disclosed herein will supersede the old form are: A more subtle medium is employed in place of carbon granules, namely, a gas or vapor thru which the current to be varied flows; there can be no packing, frying or harshness, which is caused by carbon granules and too much current; both small and large currents are allowable for use; the articulation it reproduces is as perfect as it can humanly be reproduced.

These transmitters are available for both wire and wireless telephony; and in wire telephony as distortionless repeaters as well as transmitters. They are as simple in form and nature as the microphone. Since large currents can be used in this form of transmitter, it becomes possible to modulate the antenna current directly or thru several transmitters in concatenation, in wireless telephony.



The "Edison Effect" Is Here Employed and the Magnet on the Diafram Causes Variations in the Ionic Stream.

These transmitters employ any medium known in the art as a gas or vapor or ionic, thermionic or electronic discharge, as the medium to be varied by the sound waves.

This medium may be produced by the mercury arc, by carbon arcs, by cathode and X-rays, by radium rays, by the Edison Effect, by flames into which chemicals have been placed and thru which current is past, by vacuum tube discharges of all kinds, including Tesla bulbs, by hot bodies of all kinds thru which a current of electricity is passing, including those heated by light concentrated by a lens, by photo-electric cells and by ultra violet light falling on metals or otherwise, and all these ways of producing ions are spoken of synonymously herein.

Furthermore, a combination of one or more of the above media may be employed simultaneously, as, for instance, cathode and X-rays, one inside the tube, the other outside, or both within the tube. When cathode and X-rays in combination are

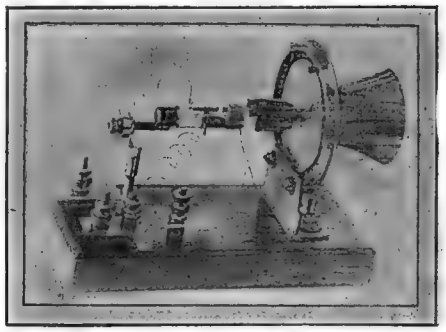


Fig. 6. Model of One Type of Gaseous Telephone Transmitter Built by the Author.

exployed, the current to be varied flows from a terminal or electrode in the X-ray tube, thru the cathode rays, thru the glass vessel, thru the air ionized by the X-rays generated by the cathode rays, to a terminal or electrode placed in the X-ray field. It is well known that the bombardment of the glass wall of the X-ray tube by the cathode rays heats it and makes a conductor of it.

The transmitters operate as a rule by throttling or obstructing means placed in the ion path, but may, of course, also operate by non-throttling means to vary the ions and consequently the current flow.

The throttling, obstructing or varying means caused to operate on any of the above media by means of sound waves can be of a material nature, including the sound waves themselves; or be of an intangible nature such as magnetism and electricity, both static or dynamic electricity; or a combination of one or more of the above means.

When magnetism or electricity is used as the throttling, obstructing or varying means perfect articulation is obtained due to the subtle means employed, namely, magnetism or electricity or both acting upon very mobile gases. The articulation will be equal to that of the Bell magneto-electric telephone transmitter, which is well known to be approximately perfect.

The magnetism for magnetic throttling

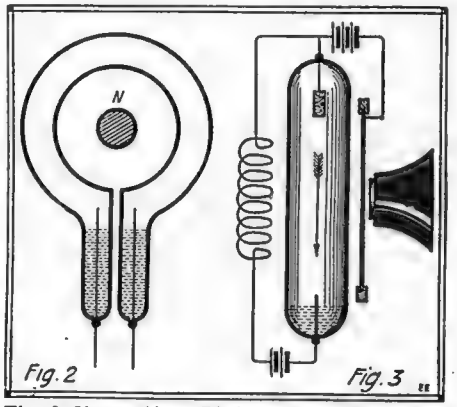


Fig. 3 Shows How Diafram May Alter Current Flow Thru Gas or Vapor Path by Electrostatic Changes.

or varying can be had from permanent or electromagnets.

The magnet may act directly upon the gas or vapor path; or upon mechanical obstructions placed in the path; or upon mechanical means, which latter in turn control auxiliary electric currents, whereby the main transmitter current is affected; or a combination of the above means may be used.

The Bell magneto-electric telephone transmitter in combination with a conducting path of gas or vapor is also possible. This transmitter may be called an "Ionophone" or "Phonion," because each signifies "speaking ion," and ions are used in all forms of this transmitter; altho it may be possible to use a liquid or granular material conducting path and have the voice controlled magnet operate upon this path.

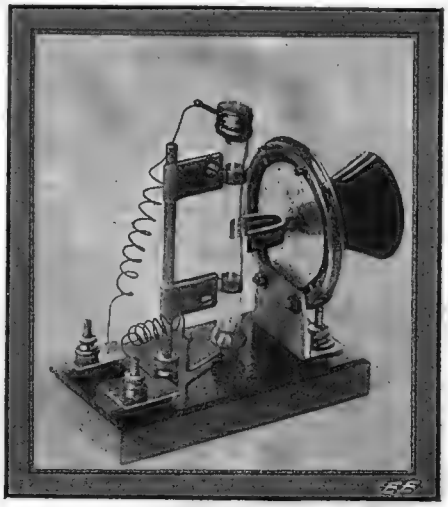
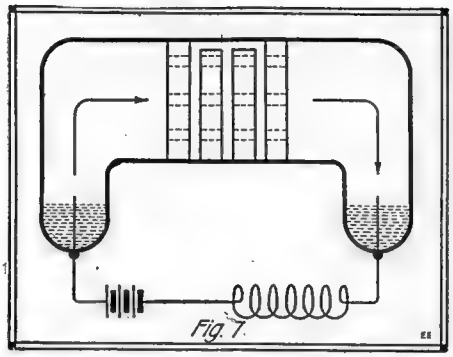


Fig. 5. Another Type of Gaseous Telephone Transmitter Devised and Built by the Author.



A Clever Form of "Valve" for Gaseous Transmitter Modulation. The Holes in the Valve Members May Be Moved Into or Out of Register.

PRACTICAL GASEOUS MICROPHONES.

I will attempt to describe in detail only the use of a few of the above media and a few ways of obstructing or varying the media in such transmitters, which will suffice to bring out the great advantages of these forms of transmitters.

Only two small current models were constructed, which, while somewhat crude, indicate the great possibilities of these transmitters. They both employ magnetism as the throttling or varying means, it being more easy to construct such models because, while simple in all forms, when one has not the necessary facilities and apparatus, other forms using internal throttling means are especially difficult to construct and it is no easy matter to find artisans who do such work. The delicate facilities and manipulations needed in the construction of first-class instruments cannot be had outside of a well-equipt laboratory or manufactory.

In Fig. 1 is illustrated a mercury arc tube, which can be provided with starting means and means to keep the arc quiet. Connected in series with the tube is a battery and an induction coil primary; the secondary of said induction coil being connected to a telephone receiver. In short, the circuit is the same as for a carbon transmitter. Adjacent the tube and partly surrounding it is a permanent magnet, N-S, which magnet is mounted upon a diafram. A mouthpiece is provided as shown. When the mouthpiece is spoken into, the diafram and magnet vibrate. The vibrating lines of force of the magnet affect the current in the mercury gas or vapor path, with the result that the vapor current is varied and this varying current reproduces in the telephone receiver what was spoken into the mouthpiece.

The diafram carrying the magnet may be vibrated by an electromagnet thru which voice currents are flowing. This, then, leads us to the telephone repeater or amplifier.*

Fig. 1 has the advantage, in wire telephony especially, over some of the other types, such as those using the Edison Effect for instance, in that only one battery is required for generating both the ions and furnishing the current which is to translate the sound waves into electrical undulations similar in form to the sound waves.

An electro-magnet may replace the permanent magnet. The core only of the electro-magnet need be attached to the diafram, the coil can be fixt in a stationary manner with the core working freely within the same. In this case we get a very strong magnet with very little material needed on the diafram; hence, the latter can respond freely and quickly to the sound waves impinging upon the same. The electro-magnet may be fed from a shunt circuit of the transmitter battery, but then reaction is quite possible and this must be guarded against by the use of an inductance coil.

When an electro-magnet is used, the Bell magneto-electric transmitter effect may come into play here, currents being induced in the stationary coil by the vibrating coil which may be added to the main effect produced by the magnet on the vapor path.

Auxiliary electrodes may be placed in the gas or vapor path and the magnet then cause the vapor to be deflected more or less from one auxiliary electrode to the other; or cause to immerse the auxiliary electrodes more or less; or cause them to approach and recede from one another more or less, in each case to get the desired variation of current in the main or auxiliary electrode circuits or both.

It is quite possible that closed iron rings placed around the vapor tube above and below the vibrating magnet may have an effect in making the vapor more susceptible to the magnet on account of the effect the rings may have on the magnetic properties of the vapor path.

Fig. 2 shows a form of mercury arc tube which makes starting of the arc easy. The anode and cathode of the tube are bent around to lie adjacent to each other; and furthermore have a large surface which makes them akin to a condenser. The vibrating, single pole magnet operates thru the center of the bent tube. If the anode and cathode are spoken to, they vibrate and thereby alter the electrostatic condition between them, thereby altering the current flowing in the vapor path.

In Fig. 1, a metal plate may be placed near the gas or vapor path, as shown in Fig. 3, a battery being in series with the plate. The vibration of the plate alters the electrostatic condition between the plate and vapor, and therefore altering the current flowing in the vapor path.

Fig. 4 shows how the "Edison Effect" is employed in such a transmitter. Here a small incandescent lamp (a four-volt one was used in the model, with a carbon filament) is shown connected to an "A" battery. Surrounding the lamp externally is the plate; this plate is in series with a "B" battery and primary of an induction coil, the secondary of said induction coil being connected with a telephone receiver. When the filament is heated, the glass also becomes heated from the filament heat and ion projection and becomes a conductor and consequently closes the circuit of the "B" battery thru the glass and ion stream within the lamp. The action of the filament heat and heat from ion projection on the glass of the lamp in this case is analogous to the heat from cathode ray or ionic bombardment of the glass tube in a Crookes or an X-ray tube; and in both cases the glass becomes conductive. In Fig. 4, when the magnet is made to vibrate, the ions in the lamp are wiped off more or less from the plate, thus causing a throttling or varying of the current from battery "B" and a resulting reproduction in the telephone receiver of the sounds uttered into the mouthpiece. The magnet will induce eddy currents in the plate, but it is evident that in this case they neutralize each other because they tend to flow in opposite directions around the plate. Anyway, the circular plate is slit in the model, so that eddy currents could not circulate in the plate, even if they did not flow in opposite directions in each half of the plate. In some cases the eddy currents can be allowed to circulate and then be utilized to affect the ion path.

The two figures, 1 and 4, are diagrammatically representative of the two models shown by the photographs and which latter are designated as Figs. 5 and 6 respectively. If very promising results can be had from such crude models, it is evident that well-constructed transmitters will perform in a manner equal to the best expectations.

When comparatively heavy currents flow in the vapor path of Fig. 1, and with a strong electro-magnet operated by the diafram, comparatively large and powerful variations will result.*

In March "Radio Amateur News"

The Armstrong Super-Autodyne Amplifier—Part II.
By H. W. Houck

The Lyons Radio Station
By Henry de Gallaix

Short Wave Regenerative Set
By J. Stanley Brown

Two Hundred Meters and What It Means.
By Pierre Boucheron

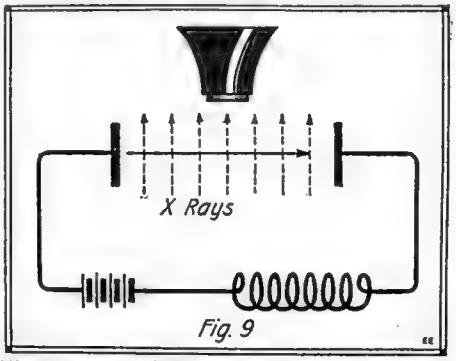
Variometers
By E. M. Sargent

Efficient Radio Club Management
By W. A. Heppner

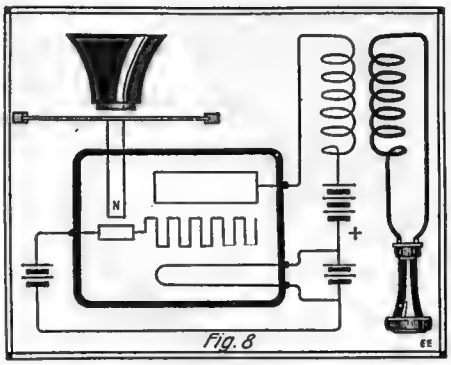
Radiophone Experiments
By Forest R. Kingman

Radiophone Section

Junior Radio Section



The Ionization Caused by X-rays Also Presents a Possible Field for Experimentation in Gaseous Telephone Transmitters.



In This Case the Diafram Magnet Member Is Caused to Act So as to Vary the Position of the Grid in a 3-Electrode Vacuum Valve.

*However, since the transmitters are capable of handling large currents, corresponding large and powerful variations are possible, which can be sent over long loaded lines without repeating.

Such a device as Fig. 1 will be reversible. Since the vibrating magnet varies the current in the vapor path of a transmitter, this varying current flowing in a similar device used as a receiver will affect the magnet and cause it to vibrate together with the diafram and thus reproduce what was spoken into the transmitter.

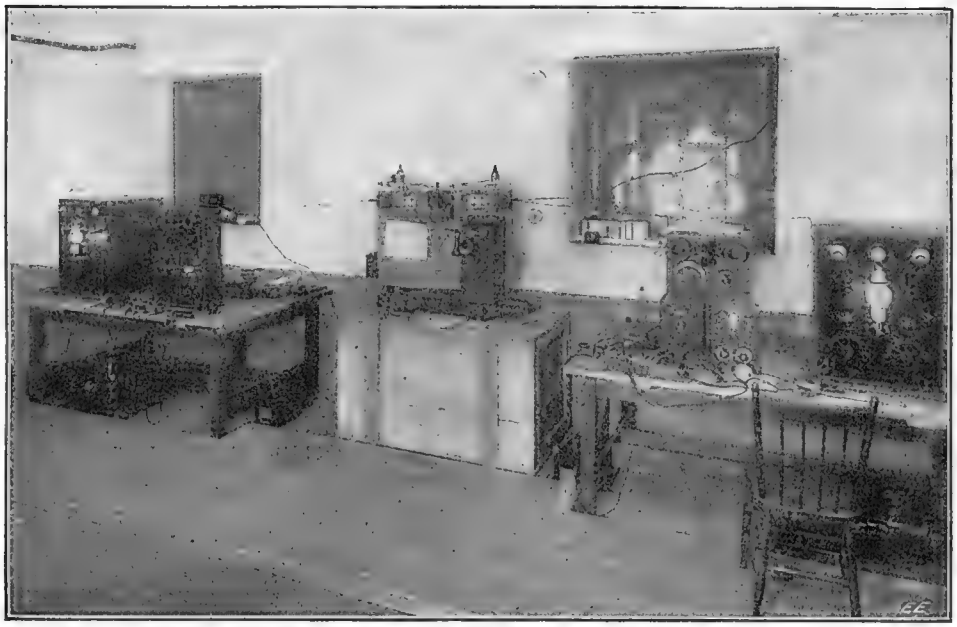
*The magnet can be located at one end of a lever and the diafram work at the other end, with the fulcrum near the diafram end, then greater amplitude of vibration of the magnet takes place.

(*Continued on page* 1200)

Radio Frequency Currents on Wires

By J. O. MAUBORGNE
Lieut. Col., Signal Corps, U. S. A.

ATTENTION was first directed, in 1911, to the practical utility of employing high frequency electric waves for transmission of energy along wires by Major (now Major General) George O. Squier. The discussion following the publication of his results indicated that, in the minds of many, the opinion prevailed that because of the excessive attenuation obtaining at the "ultra audio" frequencies, the system would be inoperative over great distances. This was thought to be particularly the case if frequencies greater than 100,000 cycles per second were employed.



The Above Photograph Shows the de Forest Audion and Oscillion Apparatus Employed In the first "Wired-Wireless" Tests in Canada, May 15-19, 1919. This Test Was Made Between Toronto and Hamilton, Over 40-45 Miles, Including in the Circuit Three Miles of Cable of the Hydro-Electric Power Commission Telephone Circuit. Wave Length, From 17,000 to 600 Meters (Iron Cable Also). Clear, Loud Speech Was Received Without Amplifier—Four Words Were Used Simultaneously Without Interference—Talking and Listening, No "Throw-Over" Having Been Required. The Current Used Was 100-150 Milli-amperes at the Transmitter End.

Recently this subject has assumed an important aspect from a military standpoint and it was decided to conduct further experiments with the object of examining the possibility of adapting certain existing types of radio-telephone and telegraph apparatus to multiplex operation. The results of the few preliminary tests which have been made recently by First Lieutenant R. D. Duncan, Jr., and Radio Engineer Samuel Isler of the Engineering and Research Division, Signal Corps, Washington, D. C., are of interest because they have shown that not only is it possible to transmit energy, at least in sufficient amounts to actuate standard "radio" receiving apparatus, over comparatively long lengths of wire circuits, but that frequencies considerably in excess of the value hitherto named as the upper limit could be employed.

The apparatus used in these tests is known as the SCR-67, which is the ground set of the standard ground-airplane radio-telephone equipment. It comprises two three-electrode vacuum tubes of the transmitting type (Type VT-2. One oscillator and one modulator) and connected circuit, a receiving tube (Type VT-1) and circuit, and a two-stage audio frequency amplifier. The method of modulation, that devised by Heising, is based on the fact that, to a very close approximation, the amplitude of the high frequency current is directly proportional to that of the E. M. F. applied between the plate and the common filament terminal of the oscillating tube; any variation of the E. M. F., for example, at an audio frequency, will modulate or mould the continuous flow or high frequency energy in a corresponding manner, which, when received by a tuned receiving circuit, and rectified, manifests itself as an audible sound in a telephone receiver. The means by which the modulation is accomplished is by a second tube, whose plate-filament path resistance is varied in accordance with the speech frequencies applied to its input terminals. By properly inter-connecting the plate or output circuits of the oscillating and modulating tubes, and by further converting the high voltage plate power supply to the two tubes from a constant potential to a constant current system, the variation in amplitude of the high frequency current may be made to follow out faithfully the variations imprest by the modulating source. This system is advantageous since the completeness and purity of modulation is practically independent of the frequency of the oscillating system.

The line may be connected to the source of oscillations in a number of ways, of which probably the most convenient is by inductive coupling.

To provide a practical means for carrying out of the tests, a wire, running from Washington, D. C., to New York City, was placed at the disposal of the Signal Corps by the Postal Telegraph Company. This line was duplexed and was in continuous operation by the Postal Company. In the first series of tests one multiplex station was established at the Signal Corps Radio Laboratory, Bureau of Standards, Washington, D. C., and a second at Dixon's Park, Curtis' Bay, Md., approximately three miles from the Postal office in Baltimore, the total wire distance between the two approximating 60 miles. The multiplex apparatus was connected to the line at these two points.

Satisfactory two-way communication was obtained; speech was received at both stations, loud and with exceptional clearness, the distortion common and inherent to long distance wire telephony being completely absent. The tuning at the receiving stations was quite definite, comparable in every respect to that when receiving signals of a "sharply" tuned radio station. This last fact permits of the operation of a number of multiplex units, each tuned to a different frequency and without the use of filter circuits on the same wire line. The carrier frequency employed in these tests was 600,000 cycles per second (wave length 500 meters); the effective line current, measured at each of the transmitting stations, averaged 60 mil-amperes. Thruout the tests the operation of the multiplex apparatus in no way interfered with that of the wire telegraph apparatus nor was interference experienced from the latter.

The satisfactory range of an SCR-67, when operating as a ground "radio-telephone" set, in communication with a corresponding SCR-67, is, under ordinary conditions, 10 miles. Thus, by confining and directing the flow of energy to a definite direction, the range is materially increased.

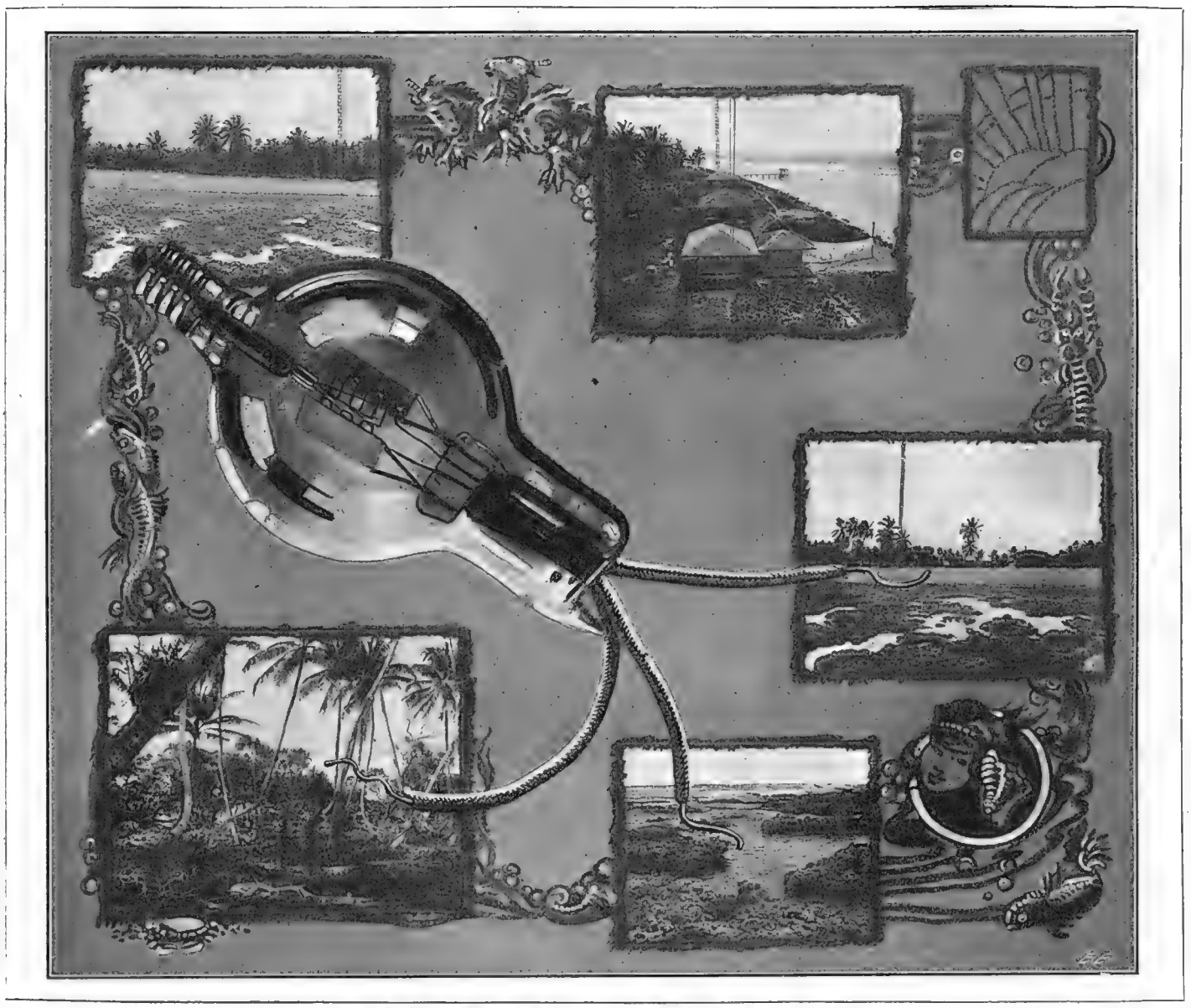
The advantages of multiplex telephony and telegraphy are many. From a military standpoint alone, it is obvious that in time of war any means of increasing the traffic handling capacity of already overburdened telephone and telegraph lines will be of inestimable value. There is a further advantage from an economical standpoint, in that certain of the existing types of Signal Corps radio-telephone and telegraph apparatus, large quantities of which were purchased during the war and which are now idle, with only slight changes in construction, may be adapted to either radio or multiplex operation. The increased range obtained makes possible the connection of outlying military posts and establishments with low power units, where ordinarily comparatively high power and consequently heavier apparatus would be required if strictly *Radio Communication* were solely relied upon.

About a year ago the American Telephone and Telegraph Company demonstrated over a circuit between New York and Pittsburgh, as well as on several other circuits, that it was successfully and accurately transmitting and receiving several telephone messages over a *single wire* at the same time, by utilizing audion generators of high-frequency currents, each frequency having a different value so as not to interfere with the others.

Major-General George O. Squier was the first to suggest the application of such currents to the multiplex telegraph and telephone system and took out patents on this system about ten years ago. The test conducted by the A. T. & T. Co. demonstrated conclusively that his "stunt" worked!

At the present time the first cost of the necessary apparatus for producing the essential high-frequency currents prohibits it from being adopted, except over certain circuits, and particularly under military conditions, where this scheme is of undeniable and invaluable advantage.

An abstract of this paper was presented at the Washington Meeting of the American Physical Society, April 25, 1919.



$25.00 For A Poem

January 6, 1920.

Mr. H. Gernsback, Editor,
Electrical Experimenter,
New York City.

My dear Mr. Gernsback:—

I have just received the enclosed very interesting communication with photographs from Washington Island.

The voyage of this little audion appeals to me as a thing fraught with romance and adventure, and a topic well worthy of a poem by some radio enthusiast.

If I could spend a couple of months away from all cares on an island of paradise in the South Seas, I could doubtless compose my soul sufficient to write a poem worthy of the theme, but our New York subway is not conducive to poetic rhapsodies. There has been altogether too little poetry on radio from its beginning. It is a subject which might well attract the pen of Kipling or Robert Service.

What do you think of the suggestion that this letter from Mr. Travers and some of his photographs be printed, together with a photograph of the wandering little bulb, and a prize offered for the best poem on the subject; award to be made by a competent board of literary men? If no poem was deemed worthy, the prize would not be awarded.

I believe there are enough broad-minded persons interested in radio matters, so that we can afford to widen the sphere of their activities and get a little bit away from the hard beaten track of everyday technics and hookups.

I shall be interested in getting your opinion on the subject.

Very truly yours,
(Signed) LEE DE FOREST.

HARDLY a month goes by that we do not read of some new wonder, some new accomplishment of that modern Aladdin's Lamp—The Audion. Its versatility was clearly chronicled in our February issue, but greater wonders are to come, much greater ones. We have but begun.

In the meanwhile the versatile audion once more accomplishes a wonder, not a scientific one, this time, to be sure, but nevertheless SOME accomplishment. The two letters printed here tell the story better than we can. It befits the occasion that Dr. De Forest, the inventor of the Audion, should suggest the idea.

Just think of a frail little vacuum glass tube traveling in the open sea—in the stormy Pacific—for thousands of miles, for months perhaps. Bobbing upon calm waves under a torrid sun, or in a typhoon, when waves run sky high. Sighting many steamers, many islands, but not "rescued" till a gentle wave lifts the little wanderer over a perilous coral reef undamaged. Thence another kind wave assisted by a zephyr, gently deposits our little be-glassed vacuum onto the velvet beach on a lonesome island in the dead of the Pacific. *And it arrives undamaged.* Forsooth what will the Audion do next!

(*Continued on page* 1186)

Washington Island,
Via Honolulu and Fanning Island,
December 1, 1919.

Dr. Lee De Forest,
New York City.

My Dear Sir:

I am sending you by parcel post an interesting valve I believe to be one of your pre-war types.

This valve traveled for many miles thru the Pacific Ocean, bobbed over a coral reef, and came to rest upon the sands of this island. Washington Island is a wee spot in the wide Pacific, having less than a dozen miles of coast. It is situated 1,000 miles southwest of Honolulu. The nearest steamship lanes are the Australian, and they are 500 miles to the westward. To the eastward there are no regular routes, with the exception of the Tahiti from San Francisco until the coast is reached. The coast is from 3,000 miles, vicinity of San Francisco, to 5,000 miles, directly east, vicinity of Panama. From which of these locations the valve has come is difficult to guess. Not far from here is the Equatorial Current, but the Counter Equatorial is between, somewhat upsetting calculations.

From wreckage picked up on the island from time to time, it appears drifting objects come from the eastward. A lifeboat came ashore here which had been washed overboard off the lower end of Lower California; a direct line of 3,300 miles.

I am enclosing a few photographs. The one of the reef will give you some idea of the hazardous end of the voyage.

I am sending this valve to you because I believe it will be of interest in your collection.

Yours fraternally,
(Signed) R. A. TRAVERS.
In charge Washington Island Radio.

Vacuum Tube Amplification

By PIERRE H. BOUCHERON

Some Timely Remarks Concerning Various Cascade Methods of Rectifying and Amplifying Either Radio or Audio Frequency Oscillations

THE amplification of received signals in radio communication was practically unknown before the advent of the Vacuum Tube, except possibly by mechanical or microfonic arrangements capable only of amplifying the sound waves produced by the diafram of the telephone receiver. This was due to the fact that crystal and similar forms of detectors are capable of rectifying properties only, and if the received signals happen to be exceedingly feeble as those transmitted from long distances, the rectified energy will not have sufficient volume to affect the diaframs of the usual telephone receivers.

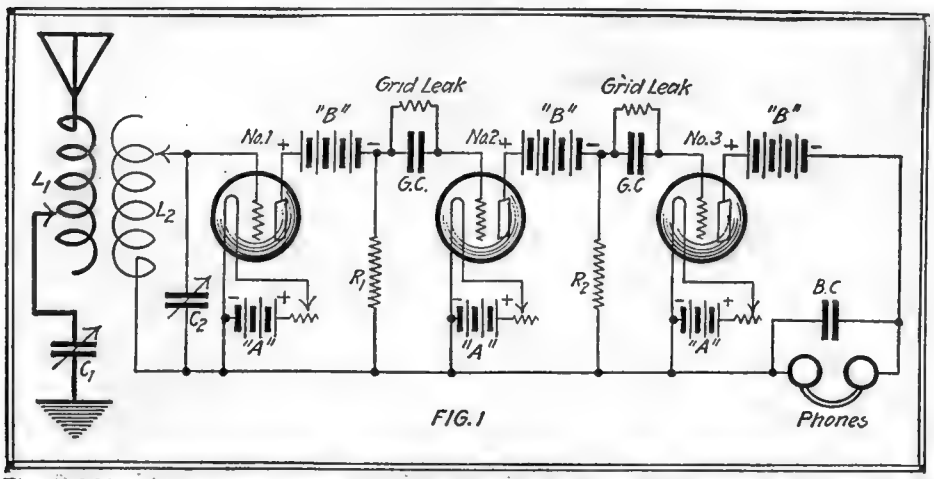


Fig. 1—This is a Possible Method of Connection Employing High Resistance Grafite Rods and Suitable for High or Radio Frequencies.

The VT, on the other hand, has proved itself most successful and valuable when applied to either or both rectification and amplification. In general, the work of the VT as an amplifier consists of repeating the grid circuit variations caused by the received antenna oscillations in the plate or output circuit, on a much greater scale than would otherwise obtain, and while it is quite true that a VT amplifier returns more energy at its output than it receives at its input terminals, yet it does not actually give something for nothing. As a matter of fact, the additional power secured from a VT amplifier or oscillator *is really at the cost of the plate circuit "B" battery.*

Amplification may be accomplisht at either radio or audio frequencies, depending on the conditions at hand, and the use to which the amplifier is to be employed. In this connection, some experimenters often wonder which is the better method and why. There are divers opinions as to the advantages of both methods, but speaking from a practical point of view, radio frequency amplification has been found more satisfactory when employed in long cascades of 4, 6 or even more stages; while audio frequency amplification is preferable when used to amplify a *rectified* current from one to two stages such as the Army and Navy two-stage amplifiers. These two methods may be modified and combined as in the case of special Navy and Signal Corps 6 and 7 stage amplifiers, by first amplifying the initial *radio frequency* oscillations up to 3 steps, then rectifying the resultant current by means of a detector VT, and finally further amplifying the rectified *audio frequency* energy up to 2 or 3 more steps; the complete operation necessitating the employment of six or seven tubes.

Before making further remarks, let us well understand the difference between so-called radio and audio frequencies as applied to amplification. Radio frequencies are those received in a tuned oscillating antenna circuit, *prior to being rectified* by a detector. These are quite high, in frequency per second, and therefore are *not audible* to the human ear which is only capable of responding to frequencies up to possibly 12,000 cycles per second. Audio frequencies, on the other hand, are those which result in a receiving system after having been rectified by a detector, and since these are usually well below 12,000 cycles, they are quite audible to the ear thru the agency of the telephone receivers. In speaking of radio frequency amplification, therefore, we mean the *magnifying* of the original antenna oscillations thru one or more stages *before actual rectification takes place;* while audio frequency amplification refers to the magnifying of the signals after they have past thru a detector and have therefore been *reduced* to a comparatively low or audible frequency.

Another important point to remember is that amplification as explained here is applicable to *either damped or undamped* wave reception; except that in the case of undamped or continuous signals, the preliminary VT circuit involves two functions, namely: the generation of a local source of high frequency oscillations and the detection of the "beats"; that is, the *resultant difference* between the locally produced oscillations and the incoming oscillations or signals. The Armstrong Regenerative Circuit is capable of doing this.

CASCADE AMPLIFICATION.

We are concerned in this article with the so-called "cascade" or multi-stage method of amplification as distinguisht from Regenerative or other means of amplification. Since VT amplification consists of greatly increasing the grid circuit variations imprest on the plate circuit to an external or output circuit, this condition when once obtained may be repeated several times in cascade fashion so that the final variations of the last tube will be many times that of the original or first tube. This final amplification, therefore, is said to have a ratio equal to the product of the amplification ratio of each individual amplifying step or stage of the cascade, and it may be several thousand times greater than the initial plate circuit variations of the first step.

GRAFITE RESISTANCE COUPLING.

In Fig. 1 we have a possible circuit diagram of a cascade amplifier employing high resistance grafite rods as a means of coupling between each step of amplification, and altho this method has several minor disadvantages, it has been found quite satisfactory for amplifying very high or radio frequency oscillations. L1, C1 and L2, C2 represent the regular oscillating tuned circuit system, where the received energy is first amplified by tube No. 1 actuated by the "A" filament and the "B" plate batteries. R1 and R2 are non-inductive grafite rod resistances of 25,000 to 100,000 ohms. Owing to the amplifying action of the VT, the original antenna oscillations are accurately reproduced across R1 and R2, but greatly increased in *amplitude* each step. The amplified energy is thus past thru the amplifying process of tubes No. 2 and No. 3, or more if desired, altho, of course, a practical limit must be reached, for the results secured with more than

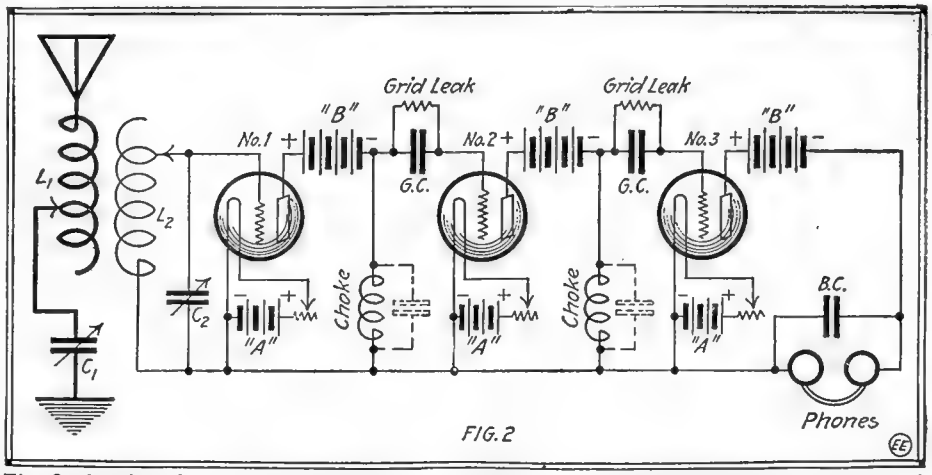


Fig. 2—Another Circuit Suitable for Radio Frequency Amplification, But Using Choke Coil Coupling Instead of Grafite Rods.

six stages of VT amplification do not warrant the use of additional and complicated appliances, unless special precautions are taken, as will be mentioned later.

The plate circuit of the last tube in cascade, therefore, is connected with the telephone receivers in series and the greatly amplified signals of radio frequency rectified and properly intercepted. In this circuit, grid condensers GC of approximately .0005 mfd. each are useful in preventing the "B" battery potentials of adjacent tubes from interfering with the proper action of the grids; while the "grid leak" resistances, which may consist of the lead-pencil-line type of about 2 or 3 megohms, (2 or 3 million ohms), are for the purpose of providing a leakage path for the negative grid charges. L1 and L2 may be a loose-coupler or two honeycomb inductances of suitable wavelength valves, depending, of course, on the length in meters of the wave to be intercepted; C1 and C2 are variable condensers of the .001 mfd. maximum capacity type. The "A" and "B" voltages depend, respectively, upon the individual requirements of the tubes employed; i.e., "A" is usually a 4 or 6 volt 40 to 60 ampere-hour storage battery (dry cells may, of course, be used temporarily); while "B" is usually a series of small dry cells of the pocket-flashlight variety, varying from 20 to 80 volts. Most VT's on the market today are furnished with operating instructions. The telephone receivers should preferably be from 2,000 to 3,000 ohms in series, and, as is usual with other receiving systems, their effectiveness may be increased by shunting them with the small bridging condenser BC, either of the variable or the fixt type and having from .001 to .0025 mfd. capacity.

In general, ideal radio frequency amplification is secured with this system when the external plate circuit has a large impedance, yet not so large as to necessitate too high a "B" plate battery potential, which latter is expensive and cumbersome.

CHOKE COIL COUPLING.

Fig. 2 shows an amplifying circuit also suitable for *radio* frequencies rather than audio frequencies, but this one employs a high inductance or choke coil coupling between each stage of amplification instead of a non-inductive resistance as with the grafite rods. These choke coil couplers, however, must each have an inductance sufficiently great so that the natural period or frequency of the *total plate circuit* is the same as that of the incoming oscillation; i. e., that of L1, C1 and L2, C2. This method of amplification is considered better than the grafite resistance coupling because, on account of the comparatively *low ohmic resistance* of the choke coils, it is possible to use much lower plate or "B" battery voltages. Also by introducing a variable condenser of the .001 mfd., maximum capacity type, shunted across each inductance as shown by the dotted lines, a high and variable plate circuit reactance is secured, a fact which makes the resulting conditions ideal for efficient radio frequency amplification. Not only that, but by careful adjusting of this LC circuit, unusual *selectivity* may be obtained—a desirable factor in preventing interference when the operator attempts to "weed out" unwanted signals of similar wavelengths.

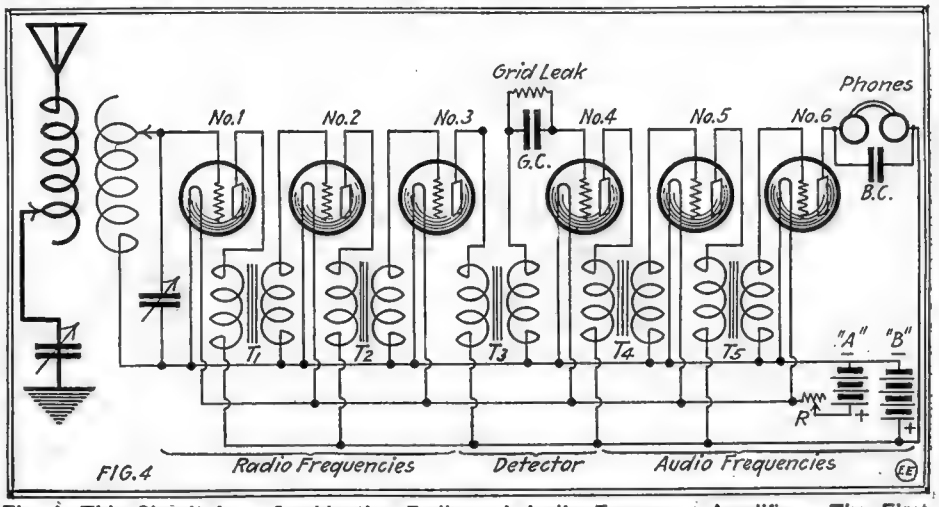


Fig. 4—This Circuit Is a Combination Radio and Audio Frequency Amplifier. The First Three Tubes Amplify at Radio Frequencies and the Other Three Tubes Detect and Amplify at Audio Frequencies.

An objection to this circuit—if it may so be called—is that it is not always convenient for the average experimenter to obtain these additional choke coils and condensers; and also that their use necessitates very careful adjustments and balancing of the two plate circuits of No. 1 and No. 2 tubes in respect to the grid circuits of their respective oscillatory systems. For the latter reason, therefore, and if selectivity is not an essential factor, preference should be given to the use of fixt choke coils of large inductance and without the aid of the variable condensers mentioned.

Other parts of this amplifier system are essentially the same as those employed in Fig. 1, except that in this case, and for the reason previously mentioned, it is not necessary to employ as high a plate voltage, from 20 to 40 volts being usually sufficient in most cases. Since most VT's on the market today are *highly evacuated*, thereby possessing no internal gases thru the medium of which excess negative charges may leak off, it is again necessary to employ the so-called "grid leak" of 2 or 3 megohms resistance across the grid condensers of tubes No. 2 and No. 3, respectively.

TRANSFORMER COUPLING.

In Fig. 3 is shown an amplifier circuit employing either *air core* or *iron core* transformers as a means of coupling between each step of amplification. This method of coupling may be used for either *radio or audio* frequencies, providing, of course, that specially designed transformers are chosen for one or the other purpose. In this particular circuit, VT No. 1 functions as a *detector* or *rectifier of the high frequency oscillations* by the use of the grid condenser GC and the grid leak GL, and the resulting *audio* or comparatively low frequency pulsations of the plate current are transferred to VT No. 2 thru the agency of audio amplifying transformer T1. VT No. 2 further amplifies the audio frequency energy and passes it on to VT No. 3 thru transformer T2 for still further amplification, where finally the total amplified energy is intercepted in the telephone receivers. One or even two more stages of amplification may be used in this or similar circuits, but special precautions must be taken in order to prevent undesirable operating conditions such as "howling" and other parasite noises caused by the local production of separate oscillations, or by the temporary stoppage of plate current flow of individual tubes. Briefly, some of these precautions may be carried out by grounding the positive side of the "B" battery; by shunting the primaries and secondaries of all amplifying transformers with suitable condensers; and by placing non-inductive resistances of high resistance in various parts of the circuit, to be determined by experiment.

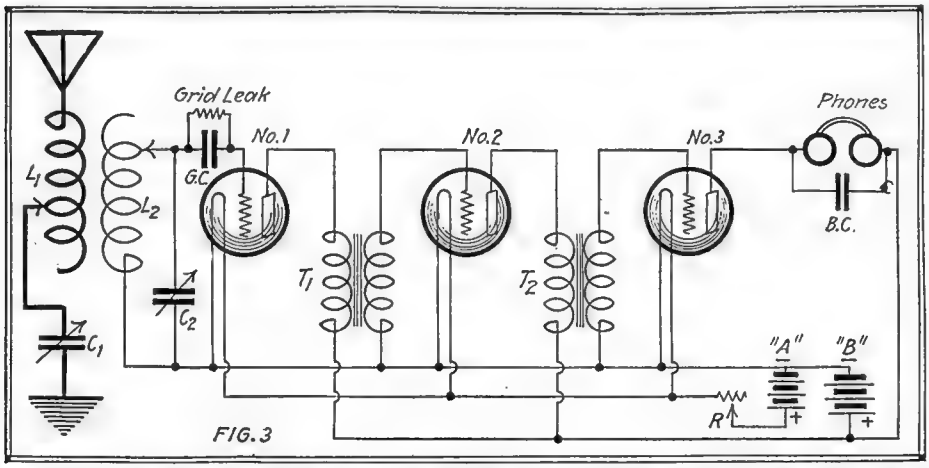


Fig. 3—In This Case We Have a Circuit Employing Amplifying Transformers Specially Designed Either for Audio or Radio Frequencies.

RADIO-AUDIO AMPLIFIER.

As a general rule, and as has been inferred before, it is quite difficult to build an efficient amplifier having more than three steps of amplification at either radio or audio frequencies without encountering undesirable noises or oscillating. It is, however, quite possible to build an amplifier which will first amplify the received signal at its *radio* frequency up to let us say three steps, then rectify the signal by means of a *detector circuit*, after which the resultant *audio* frequency is amplified up to three more steps. This method is probably the most efficient and modern one and is said to be the latest word in practical amplification. The U. S. Signal Corps have an amplifier of this type which employs seven tubes, while the Navy, not to be outdone, has just launched a similar six-step amplifier to be used in connection with the reception of very weak *Radio Compass* signals.

Fig. 4 shows a circuit diagram of an amplifier similar to the latter type. It is claimed for this amplifier that it will give

(*Continued on page* 1204)

Construction Of Honeycomb Inductances

By HILBERT R. MOORE

THE purpose of this article is to set forth the construction of the new honeycomb inductance in such a way that any amateur may make his own with little trouble or expense.

The first consideration is the construction of a machine which will wind the coils in a cellular fashion, spacing the turns properly. The materials needed are some pieces of ½" and ¾" pine, some dowel stick, a few old spools, a drawer knob, a little sheet tin, and about two dozen wood screws. A base 12" by 5" of ¾" pine is smoothed off and the two uprights CC are screwed to it. (See drawings for dimensions.) Fix uprights D to uprights C, placing shaft E, spool F and crank disk G in place. Spool F should be small in diameter or the coils will be wound too closely. Place a washer between crank disk G and support D. Brads are used to hold the spool and disk on the shaft, which is made of dowel pin.

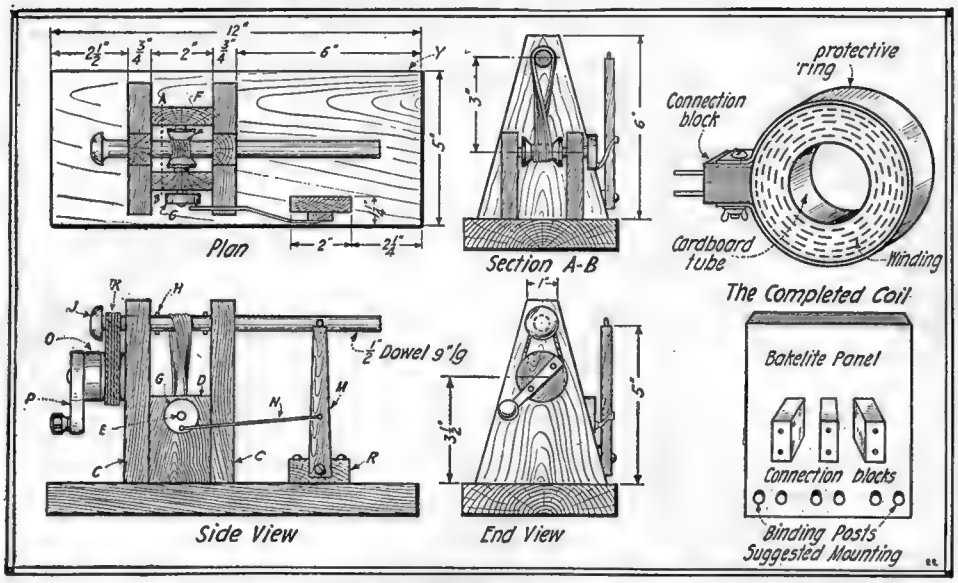
Next place spindle J of ½" dowel in holes bored for it in C C. Two pins H hold it in position. A piece of spool at J is fastened to the end of the shaft to keep the belt from slipping off. The belts may be made by passing stout cord between the pulleys seven or eight times and tying. Sandpaper glued on the spindle and spools will keep the belt from slipping. The lever M is next fastened by a screw to block R in such a way that it may turn easily. A screw eye in the top serves as a guide for the wire. The connecting rod N is made of wire. The purpose of this lever is to guide the wire backward and forward according to the speed of the spindle, and thus produce the criss-crost or cellular windings. A crank P with a drawer knob for a handle is screwed on to pulley O and the machine is complete. This winder can be used for winding string, yarn or other such materials in addition to its designed use.

The second consideration is the construction of the honeycomb coils by means of the machine described above. They may be wound on 1" sections of cardboard tubing with an outside diameter of 2". A wooden cylinder should be made which will fit on the spindle of the winder and firmly hold the sections of tubing on which the coils are wound. Cardboard or fibre disks fastened on either side of the cylinder will keep the wire from slipping off the form during the winding process. Thread the wire thru the eye at the top of the guide lever, fasten it to the spindle, and turn the crank. The winding is automatic. Number 24 S.S.C. or S.C.C. wire is best and the amount depends on the size of the coil which it is wished to wind. A winding of six layers will suffice for a short wavelength coil, while one of sixty provides a very long wavelength. Any inductance may be wound by using more or less wire. When the coil is wound, remove it from the winder and pass a thin metal band around it as shown in the figure. Secure the ends to one of the sections of a connection block such as those used with receivers.

The other section of the block may be mounted on a panel or table. Usually two or three are mounted together. By plugging in coils of various inductances, different wavelengths may be received. These coils are most effective in connection with a .001 m.f., variable condenser.

Honeycomb coils have made a big hit owing to their great saving in space.

It must be remembered that these coils are patented by the DeForest Radio Telephone and Telegraph Co., and must not be made for sale.

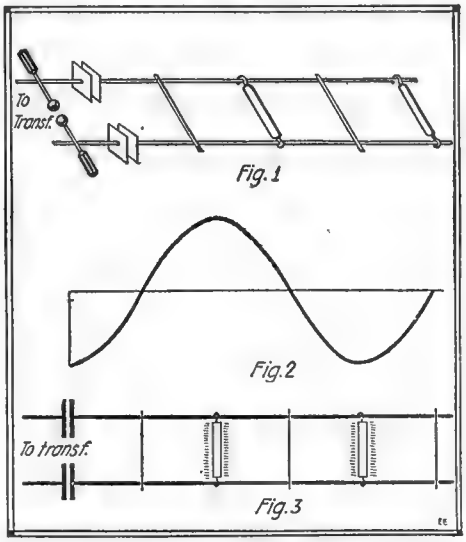


The Above Home-Made Machine Will Enable the Radio Experimenter to Construct Honeycomb Inductances Without Any Extra Expense, Except for the Wire Employed in Building Up the Coil. It Is Well to Wind a Number of Them Having Different Inductance Values.

An Experiment With Wave Motion

A striking experiment to show the pulsating character of alternating current waves can be performed in the laboratory with the aid of a small transformer or induction coil and several Geissler tubes, utilizing "standing" waves along a wire. Two lengths of bare copper wire about fifteen feet long are stretched horizontally across the room on insulating supports, separated about twelve inches. At one end a metal plate about six inches square is attached to each wire, while the other ends are left free. Two similar metal plates are supported a short distance from the first two, thus forming a series air condenser of small capacity in each wire. The last two plates are connected to a spark gap and transformer, the complete arrangement being shown in Figure 1.

When the transformer is operated, a stationary alternating current will be produced in each wire, that is, the maximum nodes of the sine wave will always remain at one point, as in Figure 2. The current values in the two wires at any given point will be of equal intensities but opposite in sign, and the maximum difference of potential will exist at the maximum nodes of the sine wave. If the Geissler tubes are connected across the wires at these points, they will light up brilliantly, while the zero nodes can be completely short-circuited by pieces of copper wire without affecting the passage of the current in the least.



Extremely Interesting Experiments With Stationary Waves on Electric Conductors. The Two Wires Along Which the Waves Are Set Up Are Connected Thru Two Air Condensers Formed of Metal Plates and Thence to a Transformer. Stationary Waves Are Set Up Along the Conductors, and If Geissler Tubes Are Connected Across the Wires at Points of Maximum Potential, They Will Light Up Brilliantly.

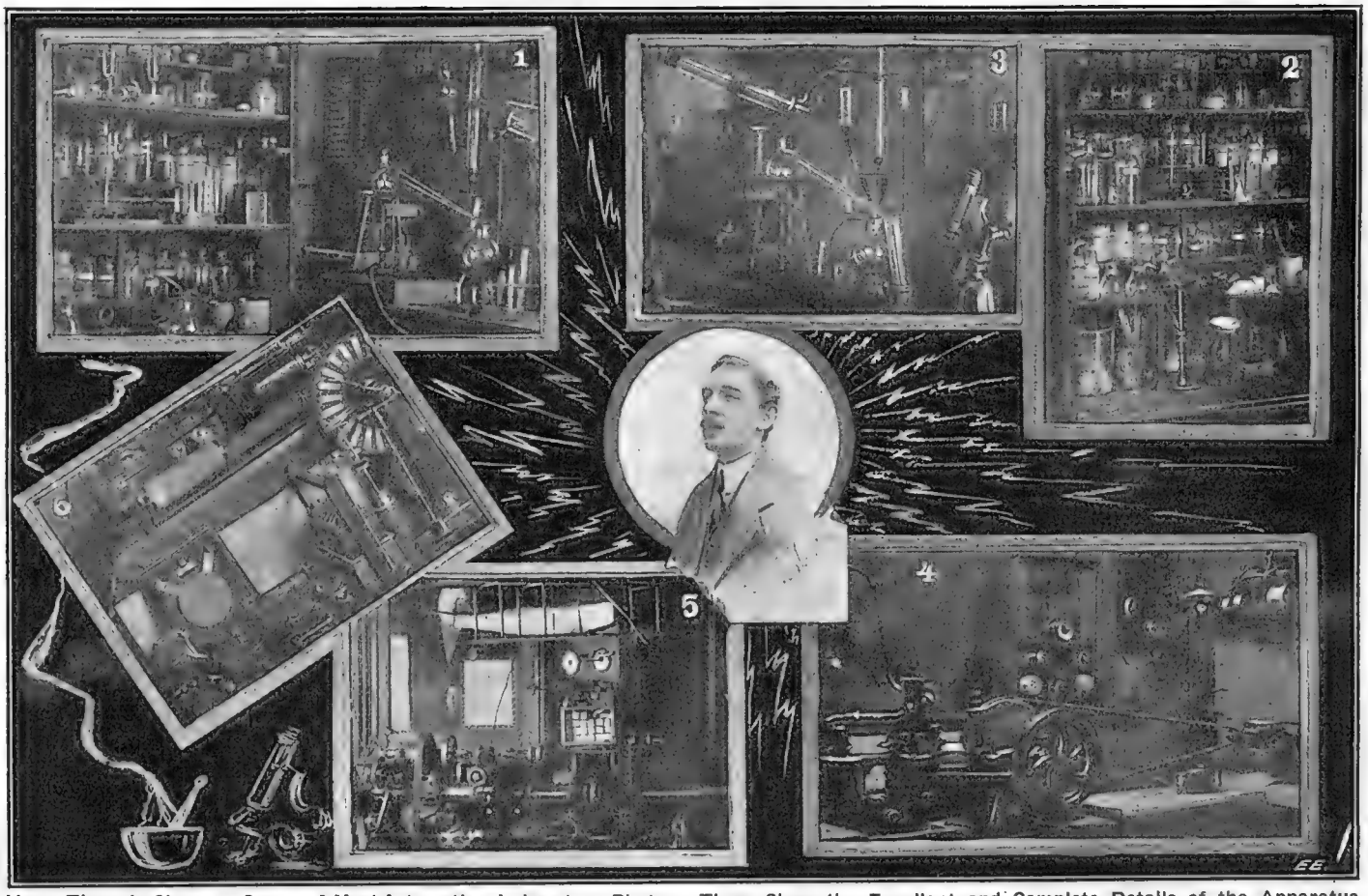
The maximum and zero points are found by moving the tubes and wires along the system until best results are obtained, adjusting the distance between the condenser plates at the same time. It is evident that a zero point must occur exactly half way between two maximum points, and the distance between two maximum or two zero points is equal to one-half wave-length. Such an apparatus is called a Lecher wave system, and is useful for demonstrating short electric waves, but it is not likely that the amateur will use this device for measuring the wavelength of his wireless transmitter.

Contributed by

L. A. BARTHOLOMEW.

POTENTIOMETER ARTICLE CORRECTION.

In the article entitled "The Potentiometer, How to Use It", by E. T. Jones, page 429 of the September, 1919, issue, an error occurred in the second diagram showing the potentiometer connected to two distinct batteries. One of these batteries should have its polarity reversed, as will be evident upon a little study of the circuit there shown. In other words the two batteries should oppose each other.



Above There Is Shown a Group of Most Interesting Laboratory Photos. These Show the Excellent and Complete Details of the Apparatus, Even to a Gasoline Engine and Lighting Dynamo, as Constructed by Its Owner—Mr. Joseph Noden, of England. Mr. Noden Has Dabbled Extensively in Electricity and Chemistry, as These Photographs Demonstrate.

An English Experimenter's "Lab"

SPECIAL PRIZE $10.00

By JOSEPH NODEN

I WAS attracted greatly by your *"With the Amateur's"* page, and I thought I would take a few photos of my experimental laboratory and workshop, which may be of interest to American amateurs, knowing they have come from their country's cousin from the other side of the Atlantic. I may add that nothing in the photos comes under my daily work, for I am a clerk in the L. & N. W. Railway Shops at Crewe.

All of the electrical apparatus are of my own manufacture, also engine and generator made from the castings (½ H. P. gasoline engine and 100 watt generator) which I use to charge my accumulators and light my laboratory and shop. The microscope is also home-made with the exception of lenses (800 times). I have a number of models, including *Curtis Tractor,* which can be seen in photos. The lathes I have are four-inch swing Drummond, also wood lathe, as well as polishing machine and grindstone (home-made). My "Lab" contains about 250 chemicals, solids, liquids and reagents, and practically all appliances for experiments under my heading. The condenser, separators, etc., were made myself from various glass tubes—also Bunsen burner, tripod and stands. I have a small room which contains bench, vises and cupboards containing mechanical and woodworking tools, shellacs, varnishes and paints; also scrap boxes which are good ones, and I might impress this on every "Amateur Scientist" never to pass an odd end, but pick it up and throw it in, for it may come in handy some day. I also have a collection of all the most important minerals found in the British Isles; the stand camera I have taken these photos with, which is my own make.

Now this one is a very important point. I am nearly thirty years of age and married, and I must say my wife is just as interested in my experiments as myself and is as anxious to see results as I am and so is in sympathy with all my work which you will agree is a great asset to any Amateur and Experimenter, but it is like this—the more time I get in my room the more I want.

SPECIAL LABORATORY PRIZE CONTEST.

As announced some months ago, we stated that for special experimental laboratory photos and descriptions an extra inducement or special prize would be offered. This month, we have pleasure in presenting an exceptionally fine experimental laboratory group, that of Mr. Joseph Noden, of England. We hope to receive more of these complete laboratory write-ups every month, and shall offer a cash prize of $10.00 for the best description, accompanied by photos, submitted.

Send photos and descriptions to Editor of "Special Laboratory Prize Contest."

As you are aware, the restrictions on wireless are still on here, and I am waiting patiently for their release (they are very slow here).

I vouch for everything I have put in this letter as being correct and true, and I have neither had any training or tuition, only text-books. In this work I have had no personal tuition whatever.

My password is "perseverance."

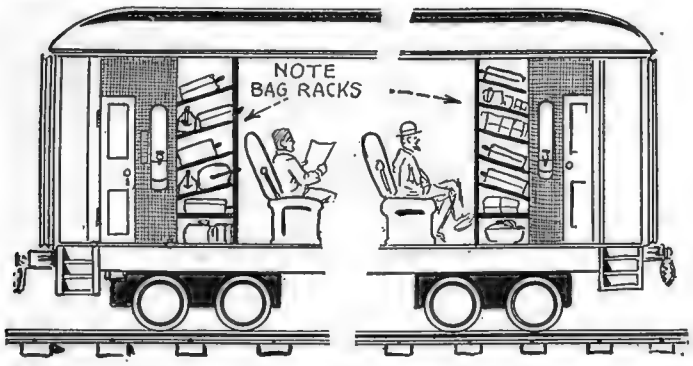
Wish your magazine every success. Joseph Noden, Fern Villa, Coppice Road, Willaston, Nantwich, Cheshire, England.

[*Editor's Note:* We shall be pleased indeed to hear from other International Experimenters with photos of their laboratories as well as of themselves. There are some excellent experimental laboratories in foreign countries, as we well know from personal experience. Many of these experimenters probably feel that New York is too far away, and that American workers in the field of science are not interested in foreign developments. But such is not the case at all. So we shall expect to hear from some of our readers in England, France, Italy, Russia, Sweden, Africa, China, Australia, and, in fact from any Experimenter anywhere. Science recognizes no nationality or creed. The ELECTRICAL EXPERIMENTER is rapidly increasing its foreign circulation, a special edition being printed for English readers now and a little later we expect to have to print French and other editions. We don't want to blow our own horn, but men from at least five European countries and Australia have told us the same thing—"You do it well! We have nothing at home that compares with the EXPERIMENTER." Dr. Alexis Carrel's assistant, a doctor of philosophy and an international scholar, was one of those who thus complimented us. Compatriots in science—we welcome you!]

What To Invent

By JAY G. HOBSON

TRAVELERS on trains these days will readily see the advantage and importance of the following improvement on the present system of accommodating passenger's personal luggage, which they ever insist upon carrying with them instead of checking same in the baggage car as provided with every ticket. But human nature persists in such peculiar characteristics, which fully accounts for the regular day coaches being jammed with all kinds of parcels, making them look very much like a "Check Room" instead of the comfortable, roomy public conveyance as originally intended.



Ever Travel Much? What's the Matter With This Idea? Bags Are Placed in Slanting Racks at Each End of Car.

This annoying condition suggests an idea for a parcel and bag rack in each end of the car, as illustrated. A compact rack made of metal tubing, so provided with individual compartments that it will hold as many parcels as there are passengers; a rack so constructed that it would be as attractive as the furnishings in the car. An efficient system as described for carrying passenger's personal parcels at either end of the car would not only be appreciated by the traveling public, but would greatly expedite loading and unloading of the coaches at stopping points. Then the item of safety is very important. Quite frequently careless passengers place their heavy suitcases, bags and belongings overhead on the parcel racks. The swaying motion of the train often throws them down upon the heads of people, causing painful injuries.

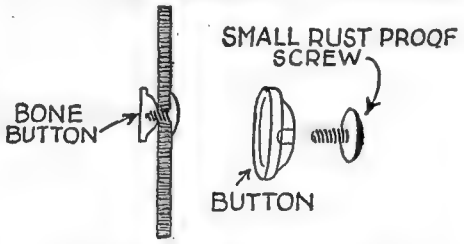
All these things would be overcome and great comfort for travelers would ensue from the application of this much needed improvement. A patented parcel rack for this purpose could be reasonably made and sold in large quantities, it seems.

A new article that would be worth while has often suggested itself to me by my personal experience with this trying and costly trouble. Just a few days ago it was again forcibly imprest upon me as being more in need than ever. A friend and I were talking about various things of interest, when suddenly he exclaimed: "By Jove, Hobson! Do you know it is the worry of my life trying to keep my coat collar from soiling my linen collar! I have tried everything, even to having my coat collar cleaned, but it seems to do no good. A few minutes after I put on a clean collar it is soiled by rubbing against my coat collar. How the deuce can a fellow eliminate this annoyance?"

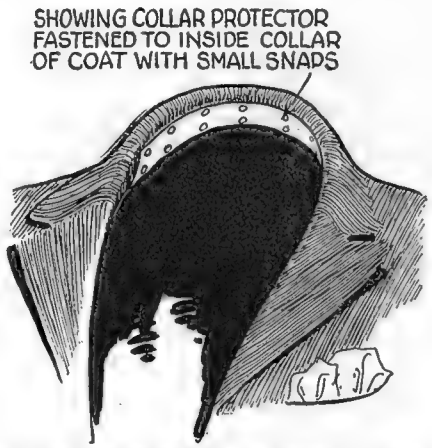
I replied that my experience had been similar and we both agreed it was a pesky nuisance. Since then the idea of the following improvement has appeared. A narrow collar-protector made of white cloth, cut to the shape of the coat collar and neck and fastened to the inside of coat collar, by very small snaps, as illustrated.

This small, invisible protector could be easily and quickly attached or detached as desired. When one had become soiled or worn, another could be attached, thereby saving excessive laundry expense and the nuisance of forever wearing soiled collars. This little device is practical in every way and would sell to most every man learning of its advantages.

Of all the disgusting difficulties to be encountered when traveling away from needle, thread and home is to lose buttons off one's undergarments, such as union suits, night gowns, pajamas, shirts, etc. Bachelor buttons of many kinds have appeared on the market from time to time, but these have all been made to replace buttons on coats, pants, overcoats and the like. Nothing in the threadless buttons for undergarments has ever been produced, to the best of my knowledge. My experience with this, "Everyman's Bother," brings to mind an improvement in bachelor buttons and especially one for men's undergarments. I see one as illustrated comprising a bone button without the usual four holes in the center, but solid instead, being somewhat thicker in the center at the back to allow for a small screw to be made of some non-rustable metal. The back center of said button would be provided with a small hole threaded to accommodate the threads on the small screw. The head or larger end of the small screw would be somewhat cup shaped and highly polisht on the surface worn against the body. This peculiar saucer-shaped screw head would grip the clothing securely when the screw was inserted thru the goods and screwed tightly into the button proper.

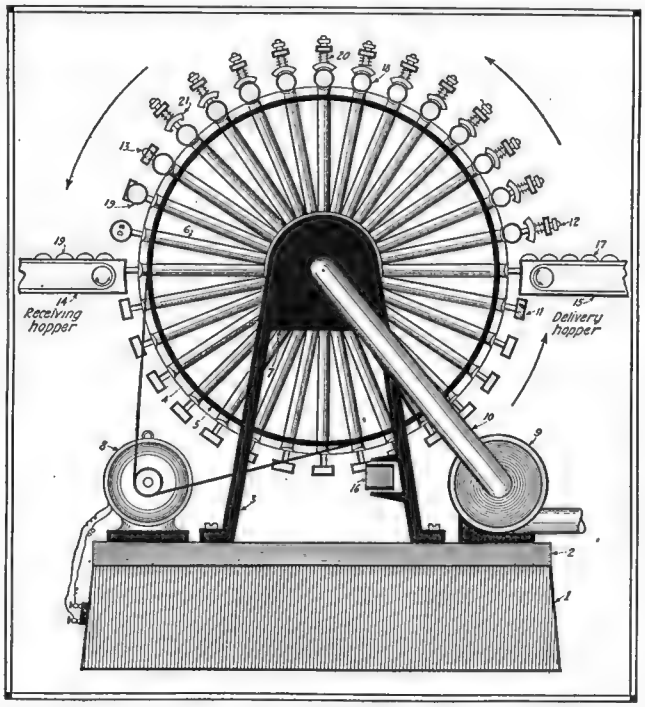


Another Idea. Why Not Make an Improvement in Bachelor Buttons?



Why Not Devise a Collar Protector to Snap Inside Your Coat, to Prevent Soiling Linen Collars?

Being screwed into the button assures a permanent fastening, and the large end of the screw prevents tearing of the garment. A button of the design would last as long as the garment and be dependable under all circumstances of wear. They could be manufactured cheaply in large quantities and sold thru dealers by the million. I am sure the masculine public would gladly buy this improvement, and it is safe to say the women folks would not object.

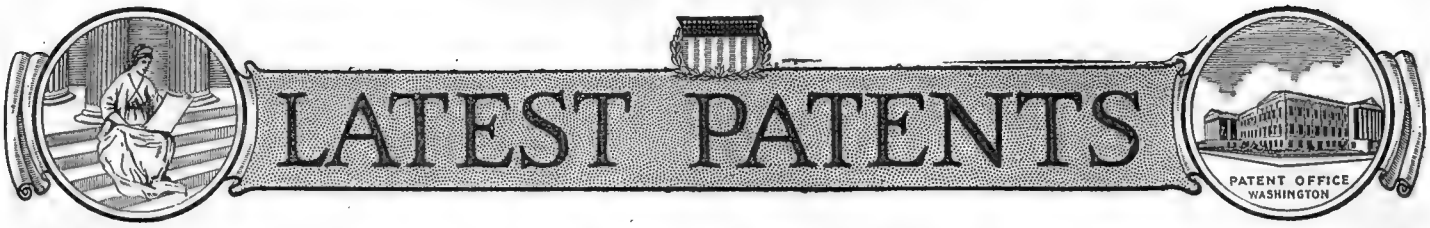


Here's a "Starter" on That $10,000 Prize Contest for a Successful Walnut Brander. Finish It, and the $10,000 Is Yours!

A $10,000 INVENTION WANTED!

Last summer a large California Walnut Growers' Association offered $10,000 to the first person succeeding in perfecting a practical machine that would automatically stamp their trade-mark on each individual English walnut so that their customers could depend upon getting their particular brand when asked for. As far as I am able to learn, this same association is still willing to pay a very good price to the inventor who submits a working model of a machine that will actually put their trade-mark on each walnut, at a small cost of operation, so that it will be permanent.

(*Continued on page* 1184)



Selenium Transmitter.

(No. 1,328,996, issued to William G. Houskeeper.)

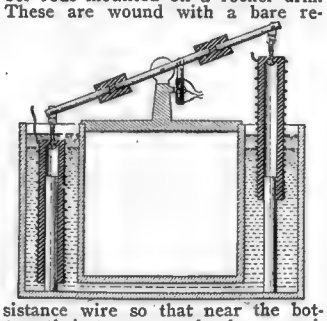
This invention relates to the use of selenium in telephone transmitters, together with improved form of transmitter. Selenium in the metallic crystalline state not only has the property of varying in conductivity when exposed to the in-

fluence of light, but also when exposed to various pressures. Herein the inventor adjusted a piece of carbon to the diafram of the transmitter, another piece to a flat spring with the pointed selenium crystal between. Either carbon or other material which will not go into chemical action with the selenium being suitable for holding it in place. Adjustment is made by the screw at the bottom of the transmitter.

Novel Rheostat.

(No. 1,329,167, issued to Robert W. Ebeling.)

An improvement in rheostats which promises to be quite revolutionizing. Very often at the movies and other places it is desirous to effect illumination of signs or produce colors or variations of colors, changing from one to the other, this, of course, being effected by two lanterns. In order, therefore, to decrease the intensity of illumination in one and increase that in the other of the two lanterns the inventor has utilized two hard rubber rods mounted on a rocker arm. These are wound with a bare re-

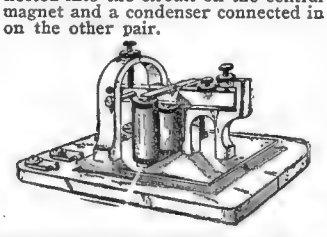


sistance wire so that near the bottom their turns are closely approximated, whereas at the top they are further apart. A solenoid actuates the rocker arm. These rubber rods being forced in this manner into two containers of mercury, which has a thin layer of oil on top of it, preventing evaporation. A two-way switch actuates the mechanism and absolute gradation of current to the lamps is made possible by the extremely simple yet unique method exemplified. There is no light flicker resulting in its use and no contacts to burn out.

Alternating Current Sounder.

(No. 1,324,536, issued to Harry K. Beasley.)

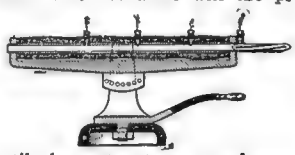
Essentially it consists of three electro-magnets, whilst the rest of the apparatus is more or less like the standard sounder, alternating currents are used of a definite phase, preferably of 90° phase difference. Non-inductive resistances are connected into the circuit on the central magnet and a condenser connected in on the other pair.



Magnetic Guns.

(No. 1,324,204, issued to Charles E. Morris.)

Magnetic guns have at all times caused considerable comment and one of the cleverest and unique devices along this line appears in this patent just issued. It consists of a barrel of polygonal cross-section so that when this barrel is mounted on its support it presents, not a perfectly straight front, but it is twisted in a spiral form. Encircling this barrel is a series of helices, the winding of these helices tightly embracing the barrel to conform with its spiral shape, altho its bore is perfectly true. By reason of this construction the inventor claims that a spiral magnetic field is provided which serves to rotate the projectile on its axis. The projectile itself has a series of spirally arranged non-magnetic inserts (copper or brass), so that the pins which make contact with the projectile will be assured of causing a positive circuit with the brass strips. The inventor claims that not alone will the pro-

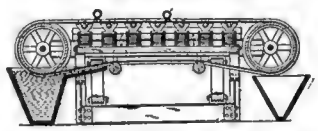


jectile be sent out at a good speed, but also a rotating motion is imparted to the projectile, the successive helices being electrified by the projectile closing contact with the pins.

Magnetic Separator.

(No. 1,324,149, issued to John E. Greenawalt.)

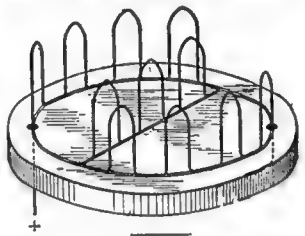
This invention is for apparatus and processes for utilizing magnetic fields for separating magnetic from non-magnetic particles and seems to be an extremely clever device. The modus operandi is as follows: Crushed ore in the form of pulp is placed upon an endless moving belt, said belt having small uprisings on both sides. A series of electro-magnets attract the particles of magnetic ore, whilst the other non-magnetic particles are washed down into a hopper, shown empty in the accompanying diagram, by streams of water emanating from supply pipes indicated by the small round circle on top of table. These pipes run transverse to the direction of the belt. Simultaneously with this is imparted an oscillating motion to the belt, which agitates the particles sufficiently to cause thoro separation. The table being slightly inclined, the poor ore is washed away, whereas the magnetic material falls over the edge now not under magnetic attraction into a hopper full of water. Here it is collected and past on to subsequent stages.



Thermic Telephone Manufacture.

(No. 321,989, issued to Pieter de Lang and R. Aernout Baron Van Lynden.)

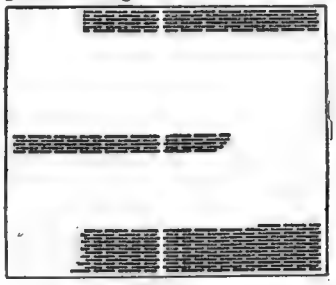
Thermic telephones coming into greater use, the inventor has realized a method of manufacturing supports for the heating conductors of the same so that this work may be carried on in a large scale. The ends of the heating conductor wires, which are bent at an angle to the branches of the wire, are forced into grooves in an insulating base and hence are connected to the support without any special means. The heating conductors connected to their support, in this manner, can be etched without difficulty to the desired sound producer length by dipping them to the required depth in an etching bath. The grooved support holding this series of wire loops in electrical contact with each other prevents the displacement of the loops by the walls of the grooves.



Storage Battery Separator.

(No. 1,329,180, issued to Walter E. Holland and James M. Skinner.)

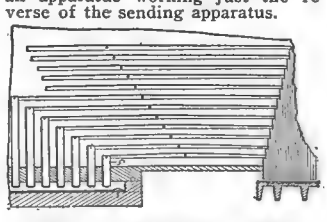
Heretofore it has been found to be practically impossible to utilize a perforated rubber separator for insulating the positive and negative plates of storage batteries, particularly those used for starting and cranking of automobiles, assuming the rôle at the same time of furnishing the voltage necessary for this purpose together with the current for the internal combustion (viz. spark coil) and lights. The battery thus not only failed to perform its primary function of cranking the engine, but failed as a reliable source of ignition. The inventors have therefore invented a separator which overcomes the drawbacks of other separators in so far as it allows for a perforation of at least 40 per cent and thus more fully exposes the positive plate surface to the action of the electrolyte. Not only is higher porosity possible, but also a method of making the separators without breaking them has been found. The main idea being to place the slots in the separator out of alignment so that greater strength is offered.



Picture Transmitter.

(No. 1,322,340, issued to Bernard Proser.)

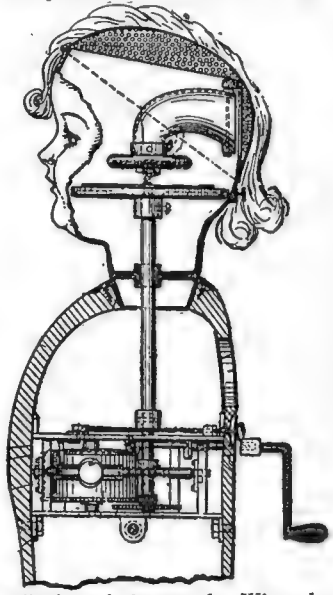
This invention relates to a method of transmitting pictures or other designs by mechanical means and was designed primarily for the purpose of enabling a newspaper office to transmit to a distant office certain important pictures, all in such a manner that the distant office can speedily reproduce the picture. It consists of a plurality of vertically positioned plungers bearing at the other end a printing character, just like the keys on a typewriter, except that they are minute in character and close together. When an embossed design is placed upon these pins it actuates all the type characters and they are printed at one stroke by the printing plungers. The characters are then transmitted by telegraph to the receiving end, where they are deciphered by an apparatus working just the reverse of the sending apparatus.



Talking Doll.

(No. 1,325,013, issued to Christoph Adolph Giebeler-Wanke.)

A doll's head is made of prest aluminum and a body of wood, the head mounted so as to be easily moved relative to the body. A phonograph motor is situated in the wooden body with a shaft extending up to the head, where the reproducer is located. A cam-like device also allows the mouth of the doll to open and close very naturally. Hair is placed on the aluminum head, covering many perforations, which allows the sound to escape from the doll. Likewise, the mouth, nose and ears are perforated to allow a free dis-

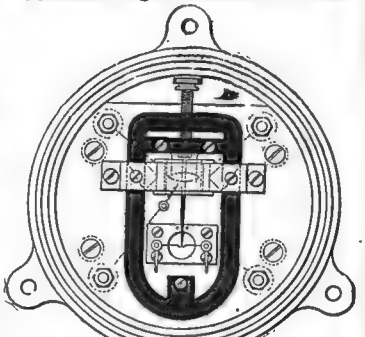


tribution of the sound. When desirous of changing a record it is only necessary to "pull the scalp back" and the head opens like a door.

Alternating Current Relay.

(No. 1,328,825, issued to Charles Vickery Drysdale.)

This is one of the cleverest alternating current relay patents which has appeared in recent years. It works on the principle of tuning or resonance. Various models utilizing the inherent principles are submitted. Essentially, it consists of a horseshoe magnet mounted on a base



which has fixt between it poles, a coil to which alternating current passes. Within this coil is pivoted a soft iron or steel needle having a platinum contact at its end. The poles of the magnet are arranged to give an intense field in the neighborhood of the needle. Adjacent to these poles is a soft iron shunt mounted on a screw so that by causing it to move a greater or less proportion of magnetic flux is shunted. In this way the control and frequency of vibration can be varied.

WITH the AMATEURS

Our Amateur Laboratory Contest is open to all readers, whether subscribers or not. The photos are judged for best arrangement and efficiency of the apparatus. To increase the interest of this department we make it a rule not to publish photos of apparatus unaccompanied by that of the owner. Dark photos preferred to light-toned ones. We pay $5.00 each month for the best photo or photos and $2.00 to each "Honorable Mention." Address the Editor, "With the Amateurs" Dept.

"Amateur Electrical Laboratory" Contest

THIS MONTH'S $5.00 PRIZE WINNERS—MESSRS. FRIDGEN and FROMMELT

HEREWITH we present photographs of our wireless set. The receiving room consists of the following: Four Edison primary batteries, which we use for audion filament current. We also use a 6-volt, 60-amp. storage battery, one standard station clock, one twelve thousand meter loading inductance, small loose coupler, Murdock variable condenser, E. I. Co. variable condenser, De Forest audion panel complete with De Forest bulb, two audio-tron panels complete with bulbs, one navy type loose coupler 4,000 meters, one "NAA" type loose coupler 3,000 meters, Marconi type receiving set, 5,000 meter range, one pair Murdock 2,000 ohm phones, one pair Brandes 2,000 ohm phones and a 500-meter loading inductance. One of our main assets in the ELECTRICAL EXPERIMENTER MAGAZINE for the last three years, and also a complete set of reference library on electrical engineering from the "I. C. S." We use 35 red seal dry cells for our "B" batteries, as we find in them the longest life. We use 2 E. I. Co. radiotone buzzers—one we use for testing our crystal detectors and the other we use on a practise set.

The transmitting set consists of the following: One one-thousand watt Thordarson transformer, type R; one five-hundred watt Packard transformer, two rotary spark gaps, two oscillation transformers, one Leyden jar condenser, one glass plate condenser, one hot wire meter, two kick-back preventers. We have two keys, one of which was built from directions found in the ELECTRICAL EXPERIMENTER. A commercial type aerial switch is used.

We are both middle-aged men, Mr. Fridgen having had seven years' experience in radio work, two years in the U. S. Navy. Mr. Frommelt has had four years of radio work at home. We can copy on an average of 28 to 30 per minute. We are both members of the Radio League of America, which we advise every amateur and professional to enter. We have had very successful results with our sets. We have been able to copy quite a large number of high powered stations, such as Arlington, Key West, Fla., Sayville, Jupiter, Fla., South San Francisco, San Diego, Cal., and practically all good sized naval stations. We expect soon to be able to hear (P. O. Z.) and other foreign stations. With our set we are able to copy two different stations at once. One man can be working on 2,500 meters and the other on 600 meters wave length.—E. N. Fridgen and F. J. Frommelt, 1645 Avon St., La Crosse, Wis.

HONORABLE MENTION, O. W. JACKSON
$2.00 PRIZE PAID EACH "HONORABLE MENTION"

MY laboratory apparatus, among other things, includes a small motor-generator set, a 6-volt storage battery and a Thordarson 1-kilowatt transformer, which are seen on the table. My receiving set is a loose coupler of my own make and an E. I. Co. detector stand; also a 3,000 ohm head set and a variable-fixt condenser. With a 60-foot aerial, 52 feet high, I can hear some of the distant stations.

I can boast of some interesting experiments in this corner. I have also made an Oudin high-frequency coil to go with my 1 k. w. transformer, and I have three 7-inch Geissler tubes and two different makes of spark gaps, four 1-quart Leyden jars, 30-ampere key, D. C. and A. C. motors, a telegraph set, a gravity battery, 4-volt D. C. motor, a carbon grain transmitter, a small rheostat and a set of Hawkins' Electrical Guides.—Oliver W. Jackson, 712 Yale Ave., Yakima, Wash.

Science in Slang

By EMERSON EASTERLING

"WHAT in the dickens is this Einstein racket we are hearing about?" Bender queried, as he scanned the pages of an automobile monthly.

"It don't have much to do with carburetors or ignition," returned Jazz, glancing down the sheet, "but *ignorance* plays a great part in it.

"It goes this way:

"Once upon a time a gent with a pencil, a well organized set of brain cells, a scratch pad, and a hunch sat before a table. He——"

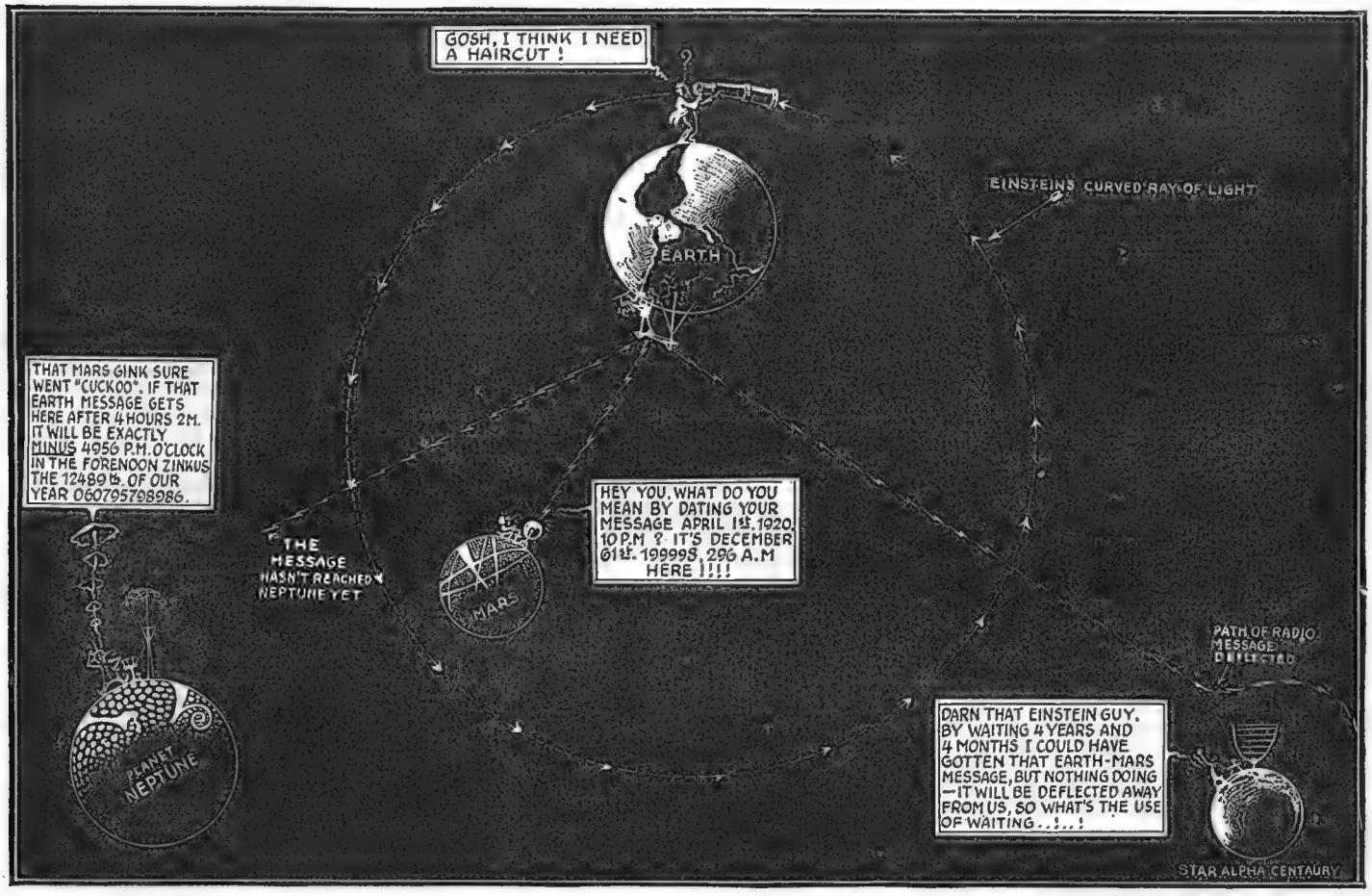
"What's Einstein got to do with that magazine?" Stew rapt out.

Relative that Einstein Theory

Isabel Lewis avers a couple of times in the January issue of this magazine (Jazz jerked from his pocket a copy of the magazine you, dear reader—if a girl, *dearest* reader, are holding in your hand—if you are) that the Newtonian laws of motion are but first approximations of the Einstein ditto.

"Like Christopher, the guy that bet on Dempsey, Wellington, Elijah—Einstein had to prove his point before the contemporary wiseacres would nod their ivories in a vertical direction and look foolish; but unlike cles and drawl tried to be at home while they played Robinson Crusoe on the island of Principe which still lies off the coast of the country that touches on the Gulf of Guinea. They, too, stayed at their location and took pictures of the star-bespattered welkin for a couple of moons, took their daily *mawnin' bahwth*, exclaimed, 'Such a blooming, bawly country!' etc.

"Packing their telescopes together, kissing the natives farewell, and exclaiming, 'Aht lawst!' they paddled their canoes back to the land where Oscar Wilde once wrote of days gone by, Shakespeare did what David Belasco and George Cohan do today; and when the guy who does the de


GOSH, I THINK I NEED A HAIRCUT !
EINSTEINS CURVED RAY OF LIGHT
EARTH
THAT MARS GINK SURE WENT "CUCKOO". IF THAT EARTH MESSAGE GETS HERE AFTER 4 HOURS 2M. IT WILL BE EXACTLY MINUS 4956 P.M. O'CLOCK IN THE FORENOON ZINKUS THE 12489 B. OF OUR YEAR 060795798986.
THE MESSAGE HASN'T REACHED NEPTUNE YET
HEY YOU, WHAT DO YOU MEAN BY DATING YOUR MESSAGE APRIL 1ST. 1920. 10 P.M ? IT'S DECEMBER 61ST. 199998. 296 A.M HERE !!!!
MARS
PATH OF RADIO MESSAGE
DARN THAT EINSTEIN GUY. BY WAITING 4 YEARS AND 4 MONTHS I COULD HAVE GOTTEN THAT EARTH-MARS MESSAGE, BUT NOTHING DOING —IT WILL BE DEFLECTED AWAY FROM US, SO WHAT'S THE USE OF WAITING...!
PLANET NEPTUNE
STAR ALPHA CENTAURY

An Actual Photograph Of All the Facts of the Einstein Theory Relatively Speaking. It Will Be Noted That the Relative Light Ray Is Quite Relative to Space to Which It Bears Some Relativity and Vice Versa. So Far for the Relativity of the Theory. This Photograph Also Shows An Important Boner of Doc. Einstein. He Has Been Telling Newspaper Co-respondents That Only Light Rays Were Curved. He Forgot To Tell Them Probably Because It Never Occurred To Him That Radio Waves Consequently Must Curve As Well. We Take All the Credit for This Important Discovery. Some Gink Will Now Please Prove To Our Electric Lighting Companies That Inasmuch As the Light Rays Received from Lamps Are Mostly Crooked, the Warped Bills Should Now Be Straightened Out Accordingly.

"Nothin'," replied the solemn Bender.

"Let Jazz string us along," I bawled out. "We haven't got over twenty-five thousand words space in this publication."

"As I was saying," Jazz continued, "the guy was *Einstein—Onestone,* I believe, translated into our language—the hunch was that the old star gawkers were barking up the wrong tree in their conception of the universe. In simple lingo, the stars were not on the spots as printed on the maps of the observatory.

"Primarily the old bird was a two-plus-two-equals-four guy, but as we often find, great mathematicians are great something-elses. This gink goes Izzy Newton one better on his propounding—Newton was right, but Einstein was *righter*—or as friend Christopher, the Dempsey fan, Wellington, and Elijah, he never had a *Santa Maria,* a Fourth of July decision, an army tired out some after a victory over the weinie caters and a bum scribe for a general, or a bunch of Baal priests with fake gods that failed to respond and a *real* one that *did;* but on a certain May 29, 1919, two expeditions of Great Britain Englishers from John Bull's Anglo-Saxon country set out for the two corners of this round ball of dirt, otherwise called earth. One gang set up their long distance opera glasses at Sobral, Brazil, took a *bawth,* then exclaimed, 'Such a blawsted, bawly country!' and showed the natives how much superior they were to the average humanus for four fortnights. The other collection of monoveloping races out with the prints dripping with water, they scramble over each other and snatch the *proof*—photographic and scientific—with mingled belief and *dis*-ditto, but exclaimed in unison, 'Bah Jove! Ripping, old top, I say.'

"Old Bert had the right dope!

"Then the scientific world raised their voice in proclaiming what Switzerland could produce besides cheese, winter sports and territory that served so nicely as Everyman's Land during the 'gunic' struggle now past, 'gunically' speaking. Albert Einstein had had his cognomen carved in the Pillars of Distinction that uphold the Hall of Fame. We now squat down at class in astronomy and listen to the proff

(*Continued on page* 1217)

THE ORACLE

The "Oracle" is for the sole benefit of all electrical experimenters. Questions will be answered here for the benefit of all, but only matter of sufficient interest will be publisht. Rules under which questions will be answered:

1. Only three questions can be submitted to be answered.
2. Only one side of sheet to be written on; matter must be typewritten or else written in ink, no penciled matter considered.
3. Sketches, diagrams, etc., **must** be on separate sheets. Questions addrest to this department cannot be answered by mail free of charge.
4. If a quick answer is desired by mail, a nominal charge of **25 cents** is made for each question. If the questions entail considerable research work or intricate calculations a special rate will be charged. Correspondents will be informed as to the fee before such questions are answered.

CHOKE COIL CALCULATION.

(1038) W. F. G., Ontario, Can., writes the Oracle Dept. in reference to choke coil design:

Q. 1. A choker (choke coil) having straight open core of 15 cm. length, and 19 sq. cm. area or 1½ x 2 inches is intended to work on 110 volt A.C. circuit, 60 cycles, B=10,000; μ=2,000, coil to pass 5 amperes when tapt at a point that gives 20 volts. I desire to know beforehand the exact magnetizing current comprising the energy and wattless components when there is no load. Please show exactly the process for working out this quantity, step by step. If I have not made the question sufficiently clear, you may assume 220 total turns of wire on the core, and that when it is merely balancing itself against 110 volts, what will be the energy losses and the idle component? Weight of core, laminated, 5 lbs. best silicon steel; resistance negligible.

Q. 2. It is desired to build an induction coil (or any kind of coil) to work on 110 volts A.C. 60 cycles, and the primary passes 2 amperes, or 220 watts (energy watts). Please show how to figure a condenser to exactly suit this particular case, assuming any other quantities if necessary.

Q. 3. Please state why the inductance in henries (L) is always converted into centimeters for wireless work, and how the "constant" if any, is obtained. It is not easy to understand how a quantity like L or self-inductance composed of $\frac{\text{Flux-turns}}{\text{C } 10^8}$ stretches out entirely into centimeters. The whole reason and process seems to me very interesting. Please explain these three questions completely.

A. 1. Since the choke coil as described is being used merely as a step-down auto-transformer, we can then obtain the magnetization current or the wattless component of the exciting current of the primary of the coil arrangement, from the following algebraic expression:

$$\text{(a).}\quad I\,\text{mag.} = \frac{10 \times 1 \times \Phi}{4\pi\sqrt{2}A\mu n_p}$$

where I mag. = magnetizing current
1 = length of core in cms.
ϕ = flux density
A = area of core in sq. cms.
μ = permeability of the core material.
n_p = primary number of turns

Total flux equals:

(b). ϕ = BA Maxwells
hence: ϕ = 10,000 × 19
= 190,000 Maxwells.

Substituting the values of the problem in equation 1, we have

$$I\,\text{mag.} = \frac{10 \times 15 \times 19 \times 10^4}{4\pi\sqrt{2} \times 19 \times 2{,}000 \times 220}$$

= .19 ampere

This being one of the components comprising the main exciting current, which produces the magnetizing flux and which is 90° behind the primary imprest voltage and in phase with the flux. The second component of the exciting current is the one that takes care of the iron losses (hysteresis and eddy current losses) and this is in phase with the imprest voltage and at quadrature with the magnetizing current or wattless component. Thus the exciting current can be exprest as:

$$I_{exc} = \sqrt{I^2_{mag} + I^2_{eth}}$$

where
I_{exc} = exciting current
I_{mag} = magnetizing current or wattless component
I_{eth} = current taking care of core losses, eddy and hysteresis losses; this is called the *power component.*

Having computed the magnetizing current, the other component I_{eth} is determined from the following algebraic expression:

$$I_{eth} = \frac{Vf(K + t^2B^2_m + nB^{1.6}_m\,10^{-7})}{E_p}$$

where
V = volume of iron in cms.³ (cubic centimeters)
f = frequency in cycles per second
K = resistivity constant = 1.6×10^{-11}
t = thickness of a single wire of iron core
B_m = maximum flux density ($\phi_m \times$ cm.₂)
n = hysteresis constant
E_p = primary potential

Substituting the values in the above expression and assuming from practise, standards such as $K = 1.6 \times 10^{-11}$ and n .0021, we have:

$$I_{eth} = \frac{15 \times 19 \times 60\,(1.6 \times 10^{-11} \times 60 \times .0635 \times 10{,}000^2 + .0021 \times 10{,}000^{1.6} 10^{-7})}{110}$$

I_{eth} = .02 ampere.

Therefore the exciting current equals:

I_{exc} = .162 ampere.

The other components of the choke coil (auto-transformer arrangement) are the copper losses both in the primary and secondary (I^2R), which cannot be determined as the size of the wire used, was not given in the problem. However, it is found by squaring the current in each circuit, and multiplying this value by its respective coil resistance.

A. 2. The electrostatic condenser capacity necessary for the secondary of a certain coil may be computed from the following expression:

$$C = \frac{2P\,10^6}{NE^2}$$

where
C = capacity in microfarads
P = secondary power in watts
N = number of times condenser charges
E = voltage of secondary coil.

In the example given it is necessary to know the secondary potential, and we will assume it to be 10,000 volts. Then substituting the proper values in the foregoing expression, we have:

$$C = \frac{2 \times 220 \times 10^6}{60 \times 2 \times 10{,}000^2} = .0366\ \text{mfd.}$$

A. 3. The reason why the value of inductance in henries in radio work is converted into centimeter units, is because the henry unit is too large; the value of the inductance of the coils used is very small in value, hence the use of the microhenry and the centimeter. However, you can use the henry if you so desire, providing the proper constant before the radical is employed.

(*Continued on page* 1168)

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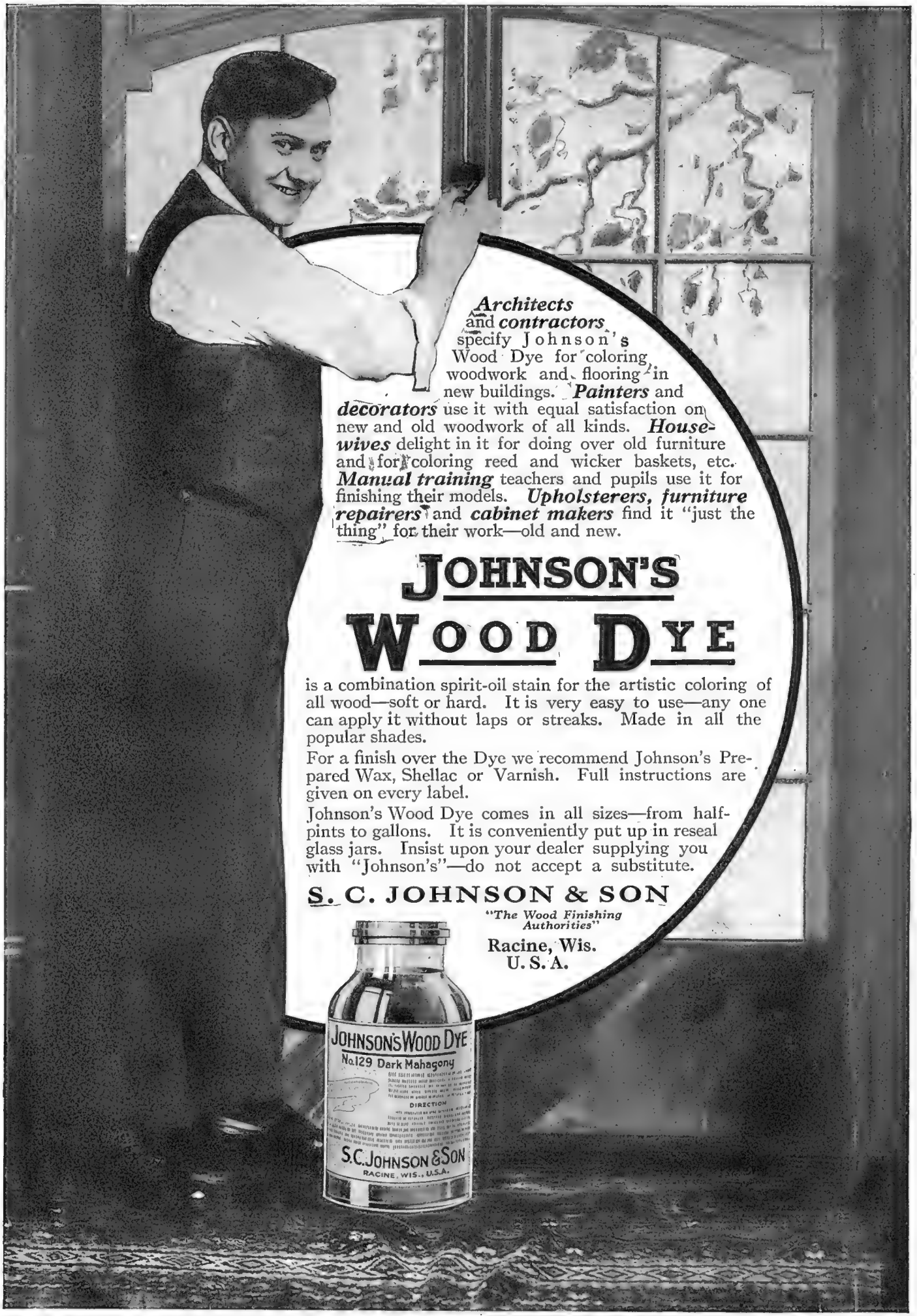

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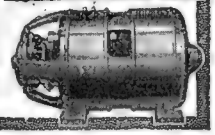

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The Oracle

(*Continued from page* 1166)

The wave length of an oscillation is exprest generally as follows:

(a). $\lambda = K\sqrt{CL}$

where
λ = wave length in meters
K = constant, depending upon what units C and L are used
C = capacity
L = inductance

Let us assume in one particular case that C will be in microfarads and L in centimeters, then the time period of the oscillation is

(b). $T = 2\pi\sqrt{CL}$

C = in farads = 10^{-6} milli-microfarads
L = in henries = 10^{-9} centimeters

Since the speed of electricity is the same as that of light, namely 186,000 miles per second, then the wavelength of an electric oscillation as compared with that of light will therefore be the same, thus:

(c). $\lambda = TV$
T = time
V = velocity of light (3×10^{10} cms. per second)

Substituting the value of T and V in expression (c) we get:

$$\lambda = 3 \times 10^{10} \times 2\pi\sqrt{C_f L_h}$$
$$= 6\pi \times 10^{10}\sqrt{C \times 10^{-6} \times L \times 10^{9}}$$
$$= 6\pi \times 10^{10}\sqrt{CL10^{-18}}$$
$$= 6\pi \times 10^{10} \times 10^{-9}\sqrt{CL}$$
$$\lambda = 1.884\sqrt{CL}$$

where: λ = wave length in meters,
C = capacity in milli-microfarads (microfarad $\times 10^{-3}$)
L = inductance in centimeters.
1.884 = derived constant

The Airship of To-morrow

By GEORGE WALL

(*Continued from page* 1113)

partments of which the one shown is a single unit, with an electric elevator to carry the passengers from one floor or deck to another.

All the comforts of home will be had on these latest airships which will soon be poking their noses over the horizon of such large cities as New York, London, Paris, Constantinople and even the far eastern cities of Japan, China, India and Australia.

There will be found among other necessary luxuries, if so we may call them, shower baths, music and smoking rooms, an electric kitchen for preparing meals for the passengers, electric lights, and electric fans for the warm weather, electric razors and massage apparatus in the barber shop and private baths, besides an electric heating system for cold weather and telephone service between the guest rooms—and speaking of the telephone it brings to mind some of the joys and pleasures of being an aerial bell-hop!

In the evening there will be motion picture shows operated by electricity, by means of a small and especially compact motion picture projector, and by the use of a powerful audion amplifier, wireless music from ship or shore stations can be picked up on the aerial of the giant aircraft as she swims along thru the clouds, and this music then reproduced thru telephonic "loud-talkers" for the benefit of the audience.

This may sound somewhat fastidious, but by these means a great deal of weight is saved in not having to carry an extra load of pipe organs or band paraphernalia for the amusement of the 1,000 passengers or so aboard!

AIRSHIP ROOMS ARRANGED IN CIRCLE.

As will be seen, the guest rooms are arranged in a circular formation on each deck, and this has many advantages as soon becomes evident. For one thing a single elevator gives impartial service to all of the rooms, in view of its central location, and there are a number of other advantages in the serving of meals to guest rooms, etc., which is more difficult to carry out on an airship such as this where a smaller number of servants would be available, than in a hotel on land.

War Inventions Disclosed

(*Continued from page* 1120)

made of copper wires forming an uninterrupted circuit by being stretched back and forth vertically. In order that the blast of the gun itself does not break the wires it is necessary to place the frames some 300 calibers away from the gun. The distance between the two frames of the Le Boulangé apparatus is variable, but in general, it is between 20 to 50 meters.

This distance between the frames is of course measured with great precisions when it is considered that the time limit down to the hundredths of a second is calculated, using as a base the distance between the two frames.

The insert, Fig. 4-A, shows how two electro-magnets in connection with the chronograph recording trigger mark the exact time elapsed when the bullet or shell strikes the first frame and when it reaches the second frame. At the moment of firing the projectile first cuts the circuit of the first frame. Instantly the long black chronometer bar begins to fall, but the instant the projectile cuts thru the second frame the second circuit is also disturbed.

The second electro-magnet instantly acts and its armature hits the chronometer recording trigger. A small pin with a knife then strikes the falling bar armature of the first electro-magnet and makes a mark easily distinguishable. Noting the time of falling of the long bar and figuring this time against the point on which the mark was made from the knife, actuated by the second electro-magnet, the time interval is readily calculated—it is in fact, almost automatic.

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Popular Astronomy

By ISABEL M. LEWIS, M.A.

(*Continued from page* 1137)

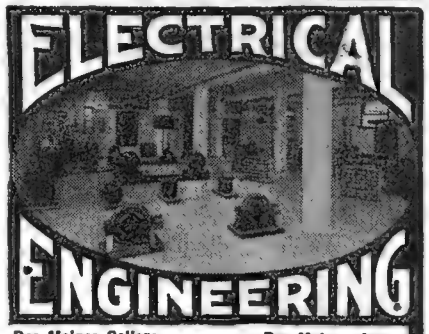
serving the transits of stars across the meridian, and which is erected with its central axis exactly in this plane, and a chronograph record in circuit with the sidereal clock for recording the instant registered by this clock when the star is on the meridian.

It is one of the duties of the U. S. Naval Observatory at Washington, D. C., to send out daily telegraphic time signals to all points in the United States east of the Rocky Mountains. Points on the Pacific Coast and in Alaska receive time signals from the Mare Island Navy Yard in Calif.

On every night when the weather permits a set of six stars, known as a "time" set, is observed at the time of their transit over the meridian of Washington.

As soon as the star drifts into the field of view of the telescope, which has been pointed approximately on the star by setting the circle readings so as to show the star's "declination" (or distance north of the equator), the observer is ready to begin his set of observations. By means of a self-registering micrometer which is designed so as to close an electric circuit automatically five times in one revolution (with an extra contact provided to mark the beginning of each revolution) two closely parallel vertical threads are made to move across the field of view of the telescope keeping the star always exactly between them. As soon as the micrometer screw has been turned a certain definite amount and the star has advanced a certain distance across the field, the first electric contact is closed and connection is instantaneously made with a chronograph record which is connected electrically with a sidereal clock and which records by a "make and break" circuit the even seconds of this clock on a sheet of paper wrapt on a cylindrical roll in the form of little jogs in a straight line occurring at regular intervals. When the observer makes electric contact with this choronograph record by means of his micrometer screw an irregular jog appears on the chronograph sheet between the positions marking even seconds and by measuring these records the exact time shown by the sidereal clock at the time when the star was a known distance from the meridian can be read to hundredths of a second of time. From the five different contacts for each star its sidereal time of meridian passage is computed.

At eleven fifty-five A. M. on every day except Sundays and holidays telegraphic connection of the transmitting clock is made by means of relays, and during the five minutes just preceding noon every tick of the clock is heard all over the United States wherever these lines extend, except that for purposes of identification the 29th second and the last five seconds of the 55th, 56th, 57th and 58th minutes and the last ten seconds of the 59th minute are omitted. The noon signal is a longer contact after the ten-second break.



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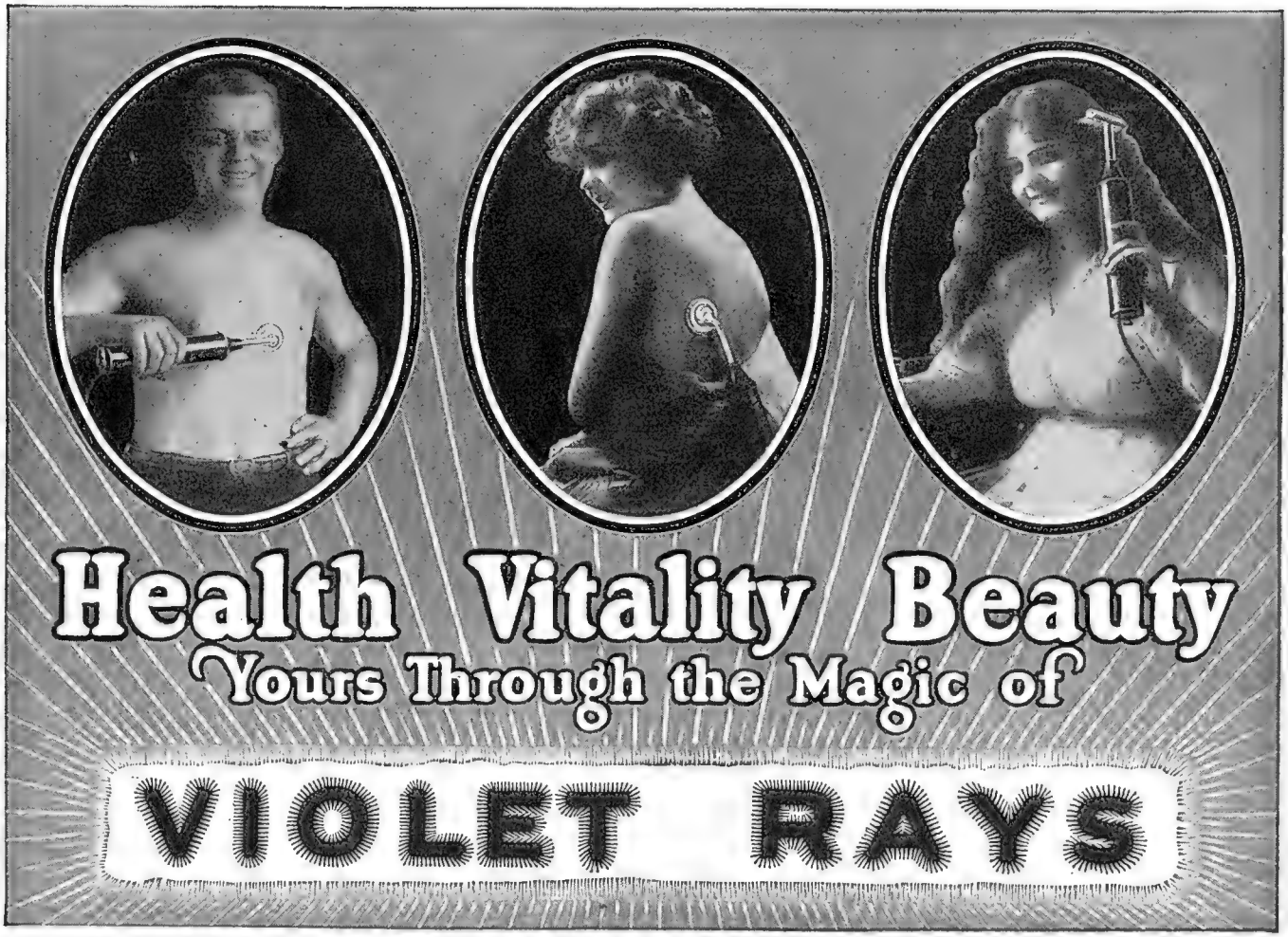

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All About Diamonds

By JOSEPH KRAUS

(*Continued from page* 1115)

for. It is always best when purchasing stones to obtain a good one.

DEFECTS IN DIAMONDS.

One of the greatest defects in diamonds is *carbon spots*. These when found in large masses make the stone practically worthless, whence it is called *carbonado*, and is used in rock drills, etc., but in stones coming from Africa and other places (except in the Mexican variety), carbon spots are seldomly found, as the cutter has used his utmost skill to clear these. The reason they are objectionable is that the spot is reflected and exaggerated many times, altho in reality it may be quite small in itself. Ofttimes a carbon spot is left in the stock but generally in such a position that when a stone is placed in a setting, it is covered by either the gold or platinum mounting. It is then more valuable to leave the spot in the stone rather than cut the stone away, making it smaller in size, as stones are sold by the carat, namely, a unit of weight. A stone is more valuable, even with small carbon spots invisible to the unaided eye, than a stone of poorer color, and it is found that in the course of examining differences in stones, nearly all of them if *pure white* have traces of carbon in them. Very often a stone has cracks or breaks across the grain or with the grain, irregular when across the grain and straight when with the grain. These breaks cause a reflection which is a very bad feature and is second to large carbon spots in regard to frequency of occurrence. They are called *cracks* when large and *feathers* or *flaws* when small. Minute feathers are not very noticeable.

DIAMOND CRAFT.

In the diamond there is a "grain" in the rough stone which grain is parallel to any of the triangular faces of the octahedral crystal. The stones in the rough are examined for perfection and assorted for sizes. The largest stones are given very close inspection for flaws and carbon spots. When these are found it may be desirable to split the stone into several smaller pieces, to eliminate the flaws and to secure stones of more marketable size. It behooves an individual known as a "cleaver" to know thoroly the grain of the diamond in the rough. Sometimes days are taken to decide on its cleavage in order to get the largest and best results—a mark is placed upon the diamond with pen and ink, a tiny groove is ground into it and the stone mounted on the end of a holder with the sharp edge of another diamond. A knife about 6" long by 1" high is now inserted into the groove or on top of the line, and with a quick blow the diamond separates easily along its grain.

There are two sets of cutters that work on this line, one called the *lopper* and the other the *brilianteerer*. The lopper makes the stone into octagonal shape. The brilianteerer cuts the facets and smaller parts, finishing the stone. When the stone is placed upon the rapidly revolving iron

(*Continued on page* 1174)

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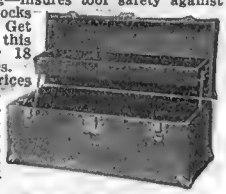

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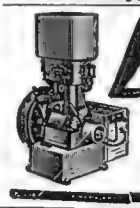

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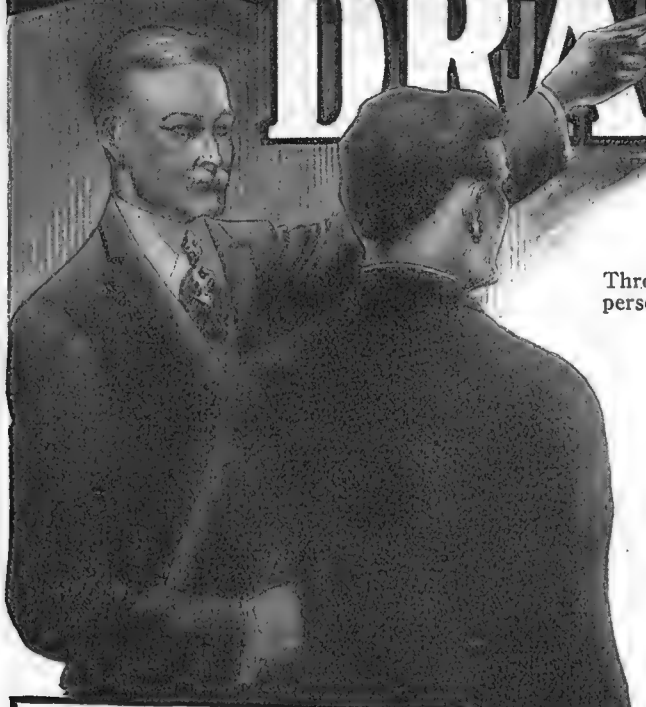

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All About Diamonds

(*Continued from page* 1172)

plate, one very strange fact noticeable is that large sparks may be drawn from the plate and are seen to fly to other metal parts. These are at least about one inch long. This typical static electric discharge comes from nothing apparently, the only explanation perhaps being that it is due to friction of the diamond against the rapidly revolving iron plate. Care must be taken that the iron plate does not have any irregularity in it, as this would result in a poorly cut diamond. The disc if necessary is scored with sand stone to make it smooth on another lathe.

Strange to say, altho many companies have put small diamonds on the market, very few have continued to follow the same line of "cut" thruout. At the firm where these photos were obtained the smallest diamond up to the largest is absolutely perfect and has 58 facets; and hence a stone of this nature would naturally be more expensive, but the slight expense for the cutting of the facets is shown markedly, if any attempt is made to resell the stone.

There are several methods of cutting stones. The *brilliant* being the finest example of the diamond cutter's art. This cut is specialized in by this concern. First is the *cabochon* or *baldpate* cut. This is a very simple cut and can be round, oval, square, cushion, or heart-shaped. The thickness is about one-half the spread in transparent stones. This cut is generally used in opals. It has a very quiet beauty of color and saves considerable weight of the stone. Sometimes in the transparent stones the bottom is slightly concave. In the *rose cut* the thickness is about one-half the spread. It is circular on the bottom and nearly pointed at the top (see illustration). It presents 24 triangular facets on its surface.

One strange fact, however, is that altho fairly brilliant, its brilliancy is dispersed and scattered. We next come to the *step cut* of which so many stones are examples. It needs practically no explanation, a glance at the diagram making this clear. We now come to the *brilliant* to which a great deal of science and skill has contributed an immense quantity of knowledge. It has been found that a back slope of a brilliant must be of a definite inclination, so that no considerable amount of light can strike more steeply than 24 degrees in order to obtain complete reflection. Likewise the angle formed between the girdle (which is the thin knife-like edge used to fasten the stone into a setting) and the sloping side for the top should be about 35 to 37 degrees and 41 degrees for the back angle. These two measurements have been found to be best. In regard to *lumpy stones*, it has been found that attempts to sell these are increasing over stones of good qualities. The reason is that the stone thus formed gives greater carat weight, but a stone of this nature is not to be desired. Sometime the thickness will cause it to leak light in the center and hence a *well* or a *dark spot* is formed. On the other hand there is not sufficient reflection if the stone is too thin and it lacks brilliancy.

The *briolette* is a pear-shaped gem drilled at the narrow end and worn as a pendant.

A FEW FACTS WORTH REMEMBERING.

We have already spoken of *paste jewelry*, but not the various forms. In glass, the edges are not very sharp, which is one of the essential differences between that and

(*Continued on page* 1176)

"You've Gone Way Past Me, Jim!"

"Today good old Wright came to my office. All day the boys had been dropping in to congratulate me on my promotion. But with Wright it was different.

"When I had to give up school to go to work I came to the plant seeking any kind of a job—I was just a young fellow without much thought about responsibility. They put me on the pay-roll and turned me over to Wright, an assistant foreman then as now. He took a kindly interest in me from the first. 'Do well the job that's given you, lad,' he said, 'and in time you'll win out.'

"Well, I did my best at my routine work, but I soon realized that if ever I was going to get ahead I must not only do my work well, but prepare for something better. So I wrote to Scranton and found I could get exactly the course I needed to learn our business. I took it up and began studying an hour or two each evening.

"Why, in just a little while my work took on a whole new meaning. Wright began giving me the most particular jobs—and asking *my* advice. And there came, also, an increase in pay. Next thing I knew I was made assistant foreman of a new department. I kept right on studying because I could see results and each day I was applying what I learned. Then there was a change and I was promoted to foreman—at good money, too.

"And now the first big goal is reached—I am superintendent, with an income that means independence, comforts and enjoyments at home—all those things that make life worth living.

"Wright is still at the same job, an example of the tragedy of lack of training. What a truth he spoke when he said today, 'You've gone 'way past me, Jim,—and you deserve to.' Heads win—every time!"

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Explain, without obligating me, how I can qualify for the position, or in the subject, *before* which I mark X.

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- ☐ Electric Lighting and Railways
- ☐ Electric Wiring
- ☐ Telegraph Engineer
- ☐ Telephone Work
- ☐ MECHANICAL ENGINEER
- ☐ Mechanical Draftsman
- ☐ Machine Shop Practice
- ☐ Toolmaker
- ☐ Gas Engine Operating
- ☐ CIVIL ENGINEER
- ☐ Surveying and Mapping
- ☐ MINE FOREMAN OR ENGINEER
- ☐ STATIONARY ENGINEER
- ☐ Marine Engineer
- ☐ Ship Draftsman
- ☐ ARCHITECT
- ☐ Contractor and Builder
- ☐ Architectural Draftsman
- ☐ Concrete Builder
- ☐ Structural Engineer
- ☐ PLUMBING AND HEATING
- ☐ Sheet Metal Worker
- ☐ Textile Overseer or Supt.
- ☐ CHEMIST
- ☐ Navigation
- ☐ SALESMANSHIP
- ☐ ADVERTISING
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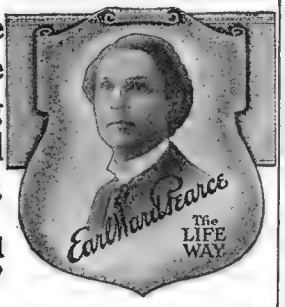

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You have doubtless heard of it, for it is well known all round the world. I lost my health, and with it, all I possessed. After years of sickness and miserable failure, I made a discovery which transformed my whole life. Then I began helping others. I have been at it a long time now, this year am helping more than ever before, and if you will let me, I will help you.

My discovery is based upon a great scientific fact—which is—that within your cells you have all the essential elements for Health, Wealth, Success and Happiness, and The Secret Formula of The Life Way is a plain, concise, definite Plan by which you release your latent and dormant forces, and set them to work, in your own right channels.

Then I show you just how to use these mighty implements of conquest, to go forth and conquer—how to develop dynamic nerves, superb muscles, supreme mind control, improved memory and intensified power of concentration—how to gain a new consciousness, get out of the ruts, make a fresh start, raise your income, get what belongs to you, and make the dreams of years come true.

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With the book, I'll enclose many reports from students, and also my absolute guarantee. So no matter what your problems may be, or what methods you have tried, here is your opportunity. Send NOW for your copy of "THE LIFE WAY." It is free, and without cost or obligation on your part, I'll promptly send you the book.

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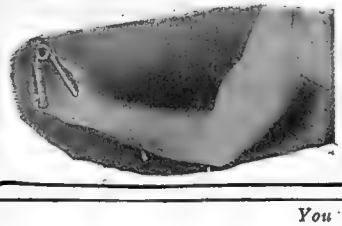


The Barker Power Grip will double and treble the strength in your fingers, hands, wrists and forearms in a remarkably short time. The Power Grip is of special value to and highly recommended by Doctors of Dental Surgery, Pianists, Telegraph Operators and Typewriters. A strong grip is admired more than any other feat of strength. In fact, it has saved many a person's life, in cases of emergency. Those who suffer from cold hands or perspiring hands will obtain great benefits by using the Grip a few minutes a day. The price of the Barker Power Grip **$1.00 postpaid**

Prof. A. BARKER, D. C., Studio 6100, 127 W. 42nd St., N. Y.

All About Diamonds

(*Continued from page* 1174)

the diamond. However, advantage of the *doublet* and *triplet* formation of stone is taken and very often the stone may be genuine in its top table or in the entire top,—the bottom, nevertheless, being of some spurious, worthless imitation. If a stone of this nature is placed into oil, the oil prevents reflection and refraction, and two distinct colors may readily be seen which of course, verifies the suspicion that the stone was not genuine. Some African stones likewise have been found to fluoresce in the dark, due perhaps to some radioactive material contained therein. This is particularly evident if the stone after having been exposed to an arc light, is rubbed on a piece of wood and then is placed in a dark room. It has been asserted and proven that color in the diamond is changed by allowing radium to act upon it.

SPECIFIC GRAVITY TESTS OF DIAMONDS.

One of the finest tests and practically invaluable is the *specific gravity* method of determining the value of stones. For this purpose a delicate chemical balance will be necessary capable of weighing in carats and fractions of carats. The method of procedure is as follows: A fine wire is suspended from one side of the balance, it having a small pan attached to one end. This is weighed in air and then in water. Now the diamond is placed upon this pan and it is again weighed in air and water; the respective weights of the wires being subtracted in both cases in order to obtain the actual weight of the diamond.

Now by subtracting the weight in water from the weight in air, we obtained the loss of weight in water and then determined the specific gravity.

$$\text{Sp. Gr.} = \frac{\text{Weight in air}}{\text{Loss of weight in water}}$$

Let us take an example:

Suppose the wire and pan weighs ..... 2 in air
And weighs ..... 1 in water
Diamond, pan, etc., weighs....12 in air
Diamond, pan, etc., weighs.... 9 in water
Subtracting weight of wire and pan in each case we get:
(a) Weight of diamond in air..... 10
(b) Weight of diamond in water..... 8

Loss of weight in water (subtracting b from a) =..... 2

$$\text{Sp. Gr.} = \frac{10}{2} \text{ or}$$

Sp. Gr. 5

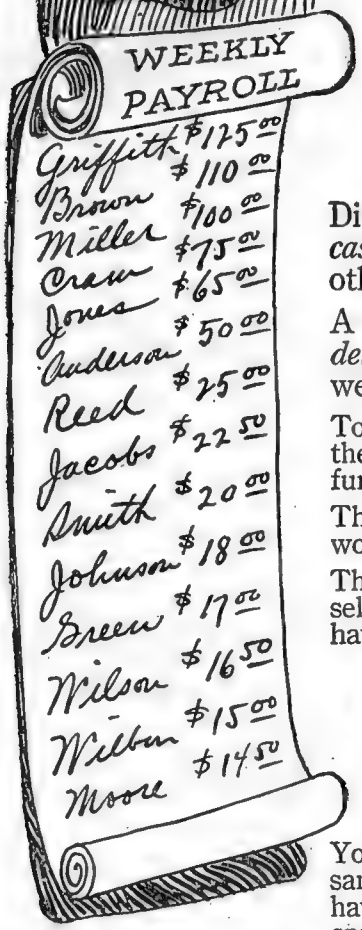
By referring our results to the table herewith we can readily determine the specific gravity for each stone, and in this way determine precisely, to a great extent, the type of stone under test.

Beryl (Emerald)	2.74
Chrysoberyl (Alexandrite)	3.73
Corundum (Ruby, Saffire, Oriental Topaz)	4.03
Diamond	3.52
Garnet (Pyrope)	3.78
Hessonite	3.61
Dematoid or Olivine	3.84
Almandite	4.05
Opal	2.15
Peridot	3.40
Quartz (Amethyst Common Topaz)	2.66
Topaz (Precious)	3.53
Kunzite	3.18
Turquoise	2.82
Zircon	4.20–4.69

In addition the specific gravity of a stone

(*Continued on page* 1178)

C. O. D.



Did it ever occur to you that all salaries are paid on a C. O. D. basis—*cash on delivery?* It is the only plan on which salaries can be figured, otherwise business would be very uncertain.

A man who is only worth $25 a week cannot expect more until he can *deliver more.* The man who can deliver service worth $75 or $100 a week to the boss expects it—*and gets it.*

To the fellow who has never stopped to think the matter over it must seem that the men who draw big pay are either "lucky" or have a "pull." Nothing is further from the truth, for "luck" and "pull" cut no ice on any payroll.

The amount on your pay check represents in cold figures just how much you are worth on the market—how much you know and *how much you can deliver.*

The men who are at the top of the payroll are there because they fitted themselves to deliver the service they are drawing big pay for. This is all you have to do to increase your pay.

RAISE YOUR OWN PAY

You can raise your own pay by increasing your delivery of service. You can easily do it—just as thousands of American School students have done—by devoting a part of your spare time to practical training. One hour after supper each night will do.

Employers won't show workers how to deliver more—but they are willing to and do pay real money to those who know how to deliver a maximum of service.

We know we can increase your delivery and are willing to guarantee ***our service*** to ***satisfy you*** or we will ***refund your money in full.*** Take ten lessons before deciding whether you wish to continue. You risk nothing, so let us know in the Coupon in which line you want to deliver more—and earn more.

American School of Correspondence
Dept. G-263, Chicago

TRAINING THE KEY TO SUCCESS

Please tell me how I can qualify for the position marked X.

.....High School Graduate	.....Business Manager
.....Automobile Engineer	.....Cert. Public Accountant
.....Automobile Repairman	.....Accountant and Auditor
.....Airplane Mechanic	.....Bookkeeper
.....Electrical Engineer	.....Stenographer
.....Electric Light and Power Superintendent	.....Fire Insurance Expert
	.....Sanitary Engineer
.....Hydroelectric Engineer	.....Master Plumber
.....Architect	.....Heating and Ventilating Engineer
.....Building Contractor	.....Gen'l Education Courses
.....Civil Engineer	.....Com. School Branches
.....Structural Engineer	.....Lawyer
.....Mechanical Engineer	.....Telephone Engineer
.....Shop Superintendent	.....Western Union Courses
.....Steam Engineer	.....Wireless Operator
.....Draftsman and Designer	.....Employment Manager
.....Photoplay Writer	

.....Foreman's Training Course

Name .....

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Finish This Picture

Fill in the missing lines. See how close you come to the original drawing. The above picture was drawn by Student Wynn Holcomb. We have a great number of students and graduates whose work appears in magazines and newspapers all over the country.

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WASHINGTON SCHOOL OF ART, Inc.
1482 H Street, N. W. Washington, D. C.

All About Diamonds

(*Continued from page* 1176)

may be obtained roughly by testing with the following solutions. If the stone floats in the first and sinks in the second, its specific gravity is somewhere between the specific gravity of one and the specific gravity of the other.

(1) Methylene iodid, saturated with iodin and iodoform, sp. gr. equal to 3.6.

(2) Methylene, iodid sp. gr. 3.3.

(3) Methylene, iodid and benzene sp. gr. 3.

(4) Methylene, iodid and benzene sp. gr. 2.65.

MISCELLANEOUS FACTS ABOUT DIAMONDS.

Stones which resemble a diamond to a great extent are colorless topaz; zircon, rendered colorless by heating; white saffire; spinel; beryl, tourmaline and even rock crystal and other minerals. All of these are double refracting except the topaz and zircon, the diamond, likewise, being only singly refracting. Strass glass resembles diamonds most, but when tested with a file will soon show its "metal." It has been found that a yellow tint in diamonds frequently is concealed by the presence of a thin coat of some blue substance sometimes used in the mounting of a stone.

Concluding we can say that the diamond is composed of carbon entirely; it is cubic in crystallography, and its cleavage parallel to faces of the *octahedron being highly perfect.* It is the hardest stone known, its index being 10. It has a special gravity of 3.52 and it appears in colorless yellow, red, blue, brown, pink, green, and black variety; when pure it is perfectly transparent. Its refractive index is 2.439. It is singly refracting and found in material known as quartzose and conglomerate in India, Brazil, South Africa, and Australia.—*Exclusive photos taken by courtesy of Fera & Kadison Company.*

Huge Siphon Tidal Power Plant

(*Continued from page* 1121)

power development schemes, but in another short span of years, when coal has become so scant that its cost will be prohibitive, at least for power house generating apparatus, and when the natural oil and gas resources of the country have become greatly diminisht, then you will see hundreds of these plants being installed on every sea coast, or wherever there is a useful rise and fall of the tide.

ELECTRICITY FROM TIDAL POWER.

The turbines operated by the water flowing under a fairly high velocity thru the siphons in one direction or other, may be connected directly with dynamos generating electric current, which can be transmitted and distributed over hundreds of miles at a potential of 200,000 volts or more, or a series of turbines may be connected to common jack shafts, by a gearing or otherwise, and these shafts in turn coupled to a single large dynamo or two, mounted on the rising and falling turbine platform or pontoon.

In the illustration herewith, one method of conducting electric current from the rising and falling turbine-dynamo pontoon is shown. Here the pontoon carries a steel mast to which wires are brought from the dynamos located in the water-proof chambers of the pontoon and from this tower or mast, the wires lead over to another mast on the stationary wall, and thence they lead to step-up transformers in a distributing station where the current is raised to a very high voltage suitable for transmission purposes over long distances.

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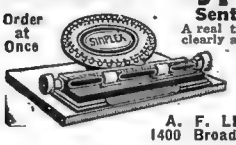

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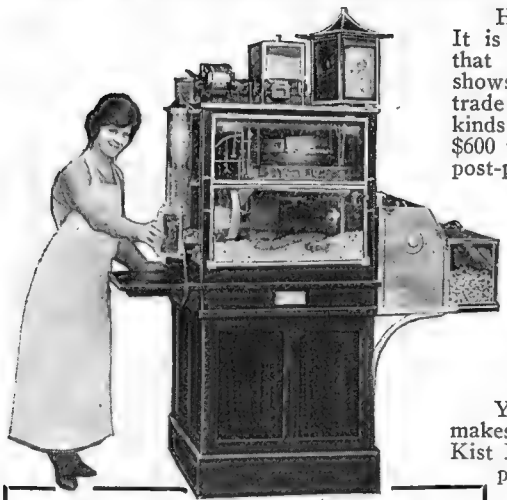
"Have averaged over $90 a week," writes theatre owner in West Virginia.

Advertised the Nation Over
Famous For Its Toasty Flavor

How Much Does It Cost You to Be Without It ?

Shows How to Make $600 to $3,120 from a Little Waste Space



Here is a book that will open the eyes of every retail merchant and theatre owner. It is called "America's New Industry." It is a startling revelation of the big money that storekeepers are making with the Butter-Kist Pop Corn and Peanut Machine. It shows letters written by the merchants themselves telling of the new profits and new trade the Butter-Kist Machine makes. It shows photographs of the machines in different kinds of stores. It proves to you in actual figures that the Butter-Kist Machine *does* pay $600 to $3,120 a year in extra net profits. Write for this book today. It is sent free and post-paid to every merchant who requests it.

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3—Toasty flavor brings trade for blocks.

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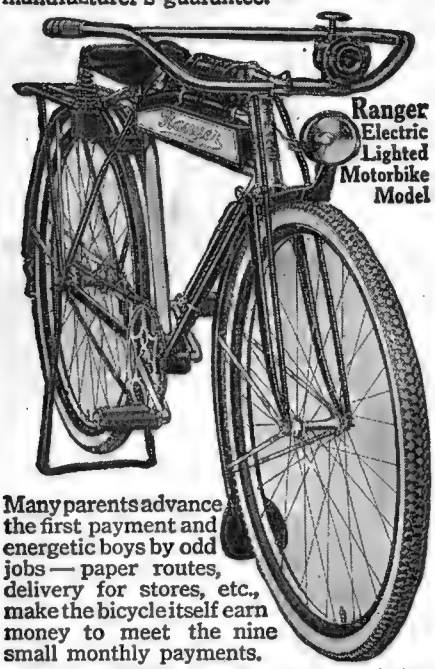

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The Electrical Machinist

By H. WINFIELD SECOR

(*Continued from page* 1151)

iron strip bent to a "U" shape and having two holes drilled thru the bottom of the "U" thru which screw eyes can be secured to the floor to hold it in position. Also there are two holes drilled thru the upper ends of the two sides of the "U" thru which a rod passes, which supports the spool.

This rod should have two holes drilled thru it on either side to accommodate cotter pins so that it will not slide out of place. Sometimes the iron support of this type is used to hold three or more spools of wire of different size, especially where the device is placed behind the lathe in a shop where a great deal of this sort of work is regularly carried on.

BANDING ARMATURES.

Figure 3 shows the process of armature banding. The armature core usually has grooves in its surface where the bands are to be placed, so that when they are finished their exterior surfaces will be flush with that of the core teeth proper. While some bands are wound over thin fiber or other similar insulating strips, the standard practice calls for a mica insulating band under the wire.

Banding mica, as it is commonly called, is a pure grade of mica of fair quality, measuring about 5" by 1", but several sizes of this mica are of course available from the mica supply houses. The thickness of the mica used will depend upon the size of the armature. A very thin piece of mica will do for small fan motor armatures, while for large armatures measuring one to two feet in diameter a much more substantial thickness of mica insulation must be used. The sheets of banding mica are first to be placed around the armature where the band is to be put in place, and these are overlapt a short distance as shown in the drawing—each successive piece of mica being held in place by a layer of friction tape, for example. One or two turns of the tape is first taken around the armature directly alongside of the spot to be occupied by the finished band, and then the operative proceeds to carefully place and bind on in position, with the tape just lapping over the edge, the successive pieces of mica. All of the mica insulation must be put in place first.

Having set up the stock wire spool and tension clamp, the banding wire (the sizes of which varies, of course, for different sizes of armatures, being small for small armatures and vice versa) is past thru the tension block, which is left loose so that the wire can be easily manipulated, and started on the armature core. Either on the lathe dog or on a piece of metal placed within one of the ventilating slots in the armature core or by some other means, the free end of the banding wire must be firmly secured. The armature, which is invariably placed in the lathe for this purpose, unless it is a very large one, is then given a turn or two, and one complete turn of the wire made on the mica.

At this juncture it is about time to put in place some small leaf copper or even thin brass strips, which are to be used in securing the band in place by soldering. The ends of these clips, of which a considerable number are put in place, depending upon the size of armature in hand, are eventually bent back over the banding wire, and thoroly soldered, as is the entire band, using a non-corrosive flux and a large soldering iron, as shown in Fig. 3, which is adapted to hold a great deal of heat, and which will not cool off quickly.

(*Continued on page* 1182)

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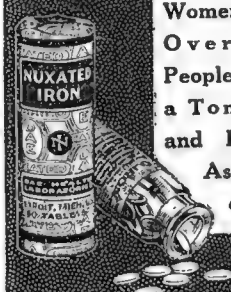

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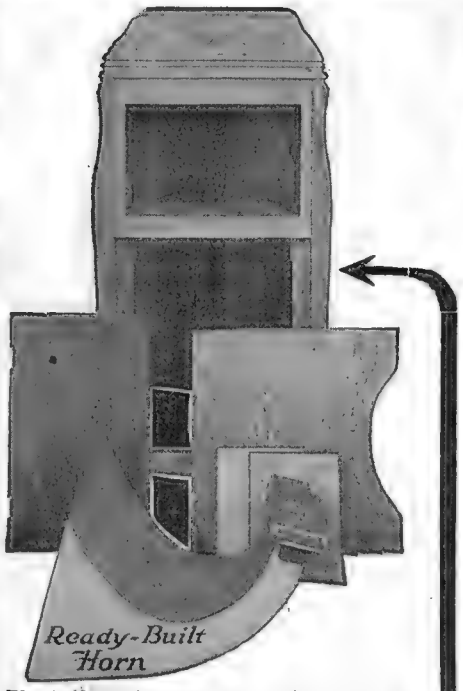

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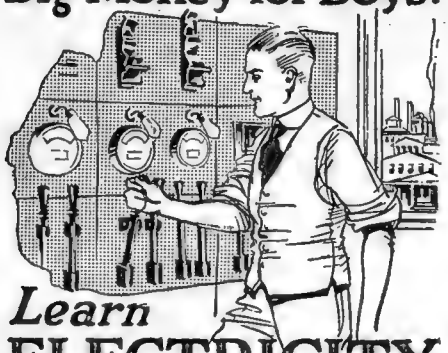

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The Electrical Machinist

(*Continued from page* 1180)

After the first turn of banding wire is put on, and the copper strips are in place, the tension block is tightened up more if necessary, and the successive turns of the band are wound on, side by side. Where the band is quite large, it is usually soldered every now and then, especially at the copper clips, as the winding proceeds. With the last turn of the band, the band in any case being always a little narrower than the mica, it is soldered all along its length and especially at the clips, with a good, hot soldering iron, so that the solder runs evenly along the turns. No lumpy solder should be tolerated, especially at the clips.

After the entire band has been soldered the ends of the clips should then be bent over, being cut in most cases so that they just meet evenly at the center of the band; these ends are prest down tightly and well sweated with the soldering iron, applying sufficient flux and solder of course. The start and finish of the band wire is usually terminated by clipping the wire on these two respective points a short distance beyond the nearest clip and bending the ends of the wires back about 1/16" along the side of the clip, altho in most cases the wire is cut even with the clip.

CANVAS HEADING OF ARMATURES.

The lead wires just back of the commutator are often covered or headed up with canvas or muslin. This trick is rather easy to perform, but it is rapidly going out of style due to the changes in design in armatures even of the smallest type. Fig. 4 shows some of the steps to be followed in heading up such an armature.

Large armatures require a piece of canvas, but small ones can be covered with a good strong piece of muslin. Unless the taper between the armature core and commutator is a very slight one, and if a decent job is to be done, then the cloth or canvas must be cut similar to the way in which lamp shades are cut, that is, in the form of a ring with a segment cut out.

For those interested in the exact procedure for the cutting of such a head to the right size, so as to make a smooth job, we would refer them to any elementary text-book on geometry, or also books on tin-smithing, as this is one of the first "tricks of the trade" that every tin-smith and sheet metal worker must learn.

The cloth head is not shellacked until it is put in place, and is often supported by a piece of paper or metal which has been cut, let us say, to approximately the proper fit, such as by cutting a templet or pattern of paper, which is laid under it. The cloth is first laid in reverse fashion around the commutator or held in place with a piece of cord temporarily. A substantial string band, not wire (which would soon cause short-circuiting of the coil leads), is wound around over the canvas and leads. This is given a coat of shellac and the cloth is then turned back over the cord, giving a very neat appearance, and is then pulled up over the armature core.

The cloth must be pulled or held very tight of course, as the banding proceeds, and if this is done carefully and thoroly a very satisfactory job will result. It is usual to simply lap the cloth where the longitudinal joint comes and to sew this up after the securing wire band has been finally put in place—but some prefer to sew it up along the joint between the commutator and the core, and "fit it," so to speak, before the wire band is put in place.

Now it is time to give this cloth head a coat of thin shellac which will cause it to shrink up in good shape.

(*To be continued.*)

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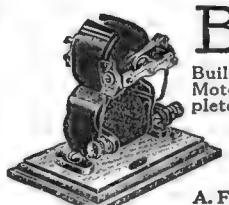

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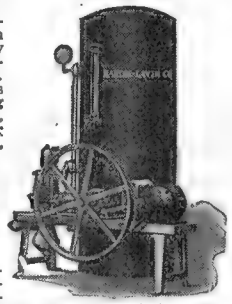

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What To Invent

By JAY G. HOBSON

(*Continued from page* 1162)

For the purpose of suggesting a possible plan for accomplishing this result, I have designed what I believe to be a practical machine in every phase of operation.

Figure 1 shows the front view of my machine. No. 1 is the concrete foundation, No. 2 is the cast iron base, No. 3 is the frame proper of the walnut-branding machine, No. 4 is the large wheel embracing the drive pulley, hollow spokes, center vacuum hub and automatic stampers attached to each individual spoke of wheel No. 4. No. 5 is the drive pulley for operating wheel No. 4. No. 6 represents the hollow spokes, No. 7 is the metal frame forming a cap for the hub of the wheel No. 4. No. 8 is the electric motor that drives wheel No. 4. No. 9 is the vacuum machine that furnishes required amount of vacuum suction for hub No. 7 and spokes No. 6. No. 10 is a large pipe connecting No. 9 with No. 7. No. 11 is the automatic stampers or branders which press down on walnuts at the proper time, thereby printing the desired trade-mark. No. 12 is the rod or shaft that operates No. 11. No. 13 is the opposite motion of No. 11. No. 14 is the receiving hopper for walnuts after having been branded. No. 15 is the delivering hopper which feeds spokes No. 6 at their periphery. No. 16 is the automatic inker that re-inks each stamp. No. 17 are the walnuts before being stampt or branded. No. 18 is walnut in process of being branded with desired trade-mark. No. 19 are walnuts after being branded with red indelible ink. No. 20 are small coil springs secured between small stamp pads and screw head on rods, No. 12. No. 21 are small rubber letters that stamp the desired trade-mark on walnuts.

The plan of operation of the above machine is as follows: When it is desired to brand walnuts, the feeding hopper No. 15 is filled with nuts. Then the vacuum machine is turned on, together with the electric motor. Large wheel No. 4 is now turning rapidly. The vacuum or suction pulls thru pipe No. 10, hub No. 7 and spokes No. 6. This strong suction causes walnuts in hopper No. 15 to adhere to each spoke passing thru the hopper. After spokes have passed above hopper No. 15, the small stamps No. 21 are caused to lower upon the nuts and are held tightly there until the other side is reached, when just before receiving hopper No. 14 is reached, the half-circle shaped trackage No. 25 recedes and permits spring No. 29 to pull stamp No. 21 up off the walnut. At the same time the half-moon shaped valve inside of hub No. 7 covers inner openings of spokes No. 6, thereby closing vacuum suction and walnut falls by gravity into receiving hopper No. 14.

Small stamps No. 21 proceed downward and are re-inked by automatic inker No. 16. Valve No. 23 shuts off vacuum on spokes No. 6 when they are passing under, which allows the entire vacuum force to be exerted on open tubes at the top, making for higher efficiency in operation of walnut brander. The capacity of this machine can be increased as desired by increasing the number of spokes and stamps of the wheel proper.

I thoroly tested out the vacuum principle of picking up and holding walnuts while being branded, and found it works perfectly. If my readers will utilize the power of vacuum in their designs, I feel certain success will crown their efforts.

(This is the second article on inventive suggestions by Mr. Hobson. The third will appear in an early issue.—EDITOR.)

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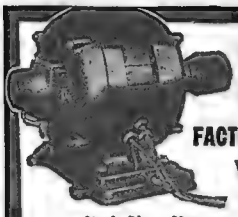

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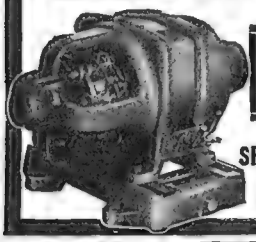

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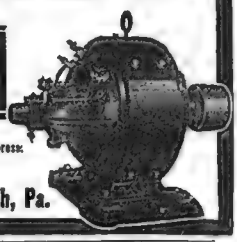

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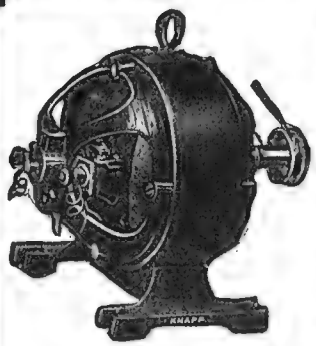

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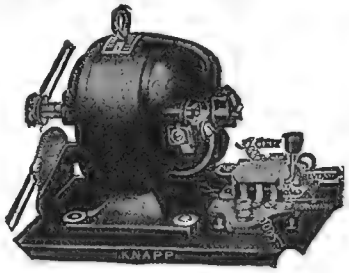

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WOMAN RADIO OPERATOR GETS CAPTAIN'S O. K.

"Thank goodness I wasn't seasick. I should never have heard the last of it," said Miss Cora T. Weber, the first woman radio operator to sail from the port of Philadelphia. She recently returned from a trip feeling "perfectly dandy," and best of all, she returned with the hearty congratulations of her captain, Edward Page.

"Miss Weber's work is excellent. I hope she will be on my ship again," said the captain, when the good ship *Grecian* docked recently.

"If I'd known I would have so much written about me, I never would have taken up this kind of a job. But I certainly do love my work. They want me to go to Baltimore to instruct in a radio school which has just been opened, but I've gotten the salt air in my nostrils and I know I'm going to turn into a regular old sea-dog, whatever that is," she smiled. "I've been offered a chance to go to Jacksonville for my next trip, and I would like to take that."

Miss Weber has gotten everything she wanted very badly, so she probably will have the honor of being the first woman operator on one of the big ocean liners too. She graduated from the Chambers School, Philadelphia, the only girl who had the courage to keep at it, out of a large class entered. Her grade in examinations was 97, and she got her first ship soon afterward.

$25.00 For A Poem

(*Continued from page* 1157)

But hist! "Whence come you little Audion? How came you to be cast upon the unhospitable sea? Your filament, your grid, your plate, ALL remain intact—only bent out of shape a bit, but you still can sing your electronic song. So we know that you were not cast upon the sea by a radio operator with murderous designs upon your frail life. Then what? Alas, you remain silent, while we gaze upon you. Were you wrecked at sea, did you go down with the ship? Did you hear your master send out his last S. O. S.? And did the ethereal reply of the responding steamer pulse thru your 'excited' body? But perhaps succor was too late, and your master was carried to the deep, clutching you in his right hand, till death parted you? Ah, we fain would know, but still you are silent. . . ."

Thus prompted we take recourse to soothing poetry, wherewith we flee to Edgar Allen Poe:

"Then this Audion-valve beguiling my
sad fancy into smiling,
By the grave and quiet decorum of the
countenance it wore,
"Tho thy grid is warpt and bent,
which De Forest did invent.
Audion! By what accident wert thou
thrown upon the coral shore?
Tell me what thy secret is on this
ether-throbbing shore?"
Quoth the Audion, "Nevermore!"

So you see the Audion either won't or can't tell its secret. Therefore we call upon our radio poets for the best poem explaining the deep mystery.

There are no rules, except that the poem must be a first class one. Dr. De Forest as well as several well-known poets will decide which poem is entitled to the $25.00 prize. We hope it will be a classic—and for that reason it must not be too technical—and not too lengthy, please.

The contest closes June 10, 1920.

Address all poems to:

Audion Poem Editor, care of this publication.

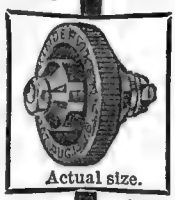
SKINDERVIKEN TRANSMITTER BUTTON

MOST SENSITIVE MICROPHONE

FOR $1.00

YOU can easily make a highly sensitive detectophone by using a Skinderviken Transmitter Button to collect the sound waves. You can build your own outfit without buying expensive equipment. Think of the fun you would have with such an instrument! It's very simple, too, and inexpensive.

You can install an outfit in your home and hear the conversation being held all over the house. You can connect up different rooms of a hotel. *This outfit was used by secret service operatives during the War. It is being used on the stage.*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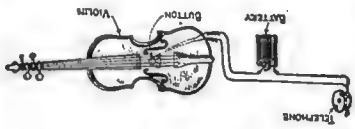
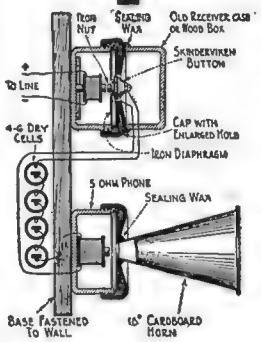


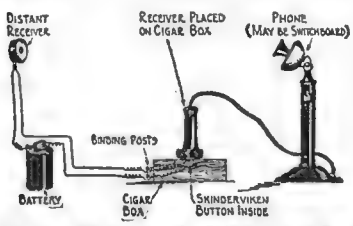
So much for its commercial adaptations! *You* can procure apparatus of the same type.

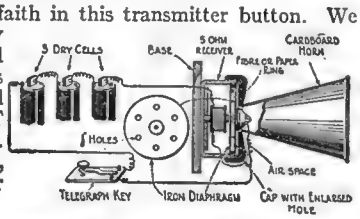
One of the main advantages of the Skinderviken Transmitter Button lies in its ultra-sensitiveness. You can place it in any position you like. It is the greatest invention in micro-phones and has won recommendations from men of high standing in the scientific world. It is being used all over the world. You can mount it most anywhere. Card board boxes, stove pipes, stiff calendars and hundreds of other places will suggest themselves to you. The buttons cannot be seen by any one in the room as they are so small and light. Only a small brass nut is exposed to the view.



Full directions for connecting up the button for use as a detectophone are given in booklet which is sent with each button.

The only instruments needed to complete a detectophone outfit, in addition to a Skinderviken Transmitter Button are a receiver, battery, and, if desired, an induction coil.





"I received transmitter button today and I wish to inform you that it works great and is *the best I have ever seen or heard of for the price.* I will certainly recommend it to my friends. I wish to thank you for your good service."

"I have been using one of these transmitter buttons, and it has proved to be worth more than its value in my experimenting." "I received one (Transmitter Button) some time ago, and they are just O. K. for experimenting." "I have been using one of these transmitter buttons for experimental work and it certainly lives up to all you say for it *and then some.*"

Mr. H. Gernsback, editor of this magazine, who is the dean of electrical experimenters, said: "In the writer's opinion, obtained by actual elaborate tests, the Skinderviken Transmitter Button is probably the most efficient device of its kind on market today, due to its simplicity and other outstanding features. Should have a great future."

The same circuit connections apply to all experiments, regardless of how the transmitter button is mounted.

The Skinderviken Transmitter Button operates on one or two dry cells. It often happens that two cells produce too much current and the sounds are deafening. We recommend either one fresh cell or two worn out cells.

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New Researches in Gravitation

By QUIRINO MAJORANA

(*Continued from page* 1124)

What we see here as a delicate laboratory experiment may give us an idea of phenomena as grand as those of the attraction generated by the stars.

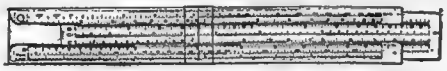
Now the Newtonian force is a sort of action at a distance, governed until now by a rigorous law. No special contingency has yet sufficed to weaken the rigor of that law. To explain this, I want to examine the other laws that seem to offer an analogy with that of Newton; these laws are those that govern the propagation of action at a distance. Known actions at a distance are often propagated through some medium. Thus the attractive action between two electric masses, that between two magnetic masses, those of electromagnetism, radio-telegraphy; those of optics, etc. All of these have principally a vibratory character, and it is admitted that the presence of a medium of propagation is necessary for their production. This medium is usually the cosmic ether. But as regards the propagation of such actions as these it is observed that when the medium is changed the measure and quality of the observable phenomena change also. Thus, if in the electric and magnetic phenomena we substitute some material substance instead of the merely hypothetical ether, the action is changed or is reduced as a consequence of the so-called electric or magnetic permeability of the medium. Then there are actions of a mechanical and others of a calorific nature which are not propagated in a vacuum (ether) and which need a material medium. From which we may conclude that all known action at a distance is in its manifestation dependent upon the nature of the medium.

For universal gravitation alone nothing of the sort has yet been found. The Cavendish balance always gives the same result, even if the medium thru which the forces of attraction are manifested be not the air but for example a heavy body like a lump of lead. An experiment performed by Laager several years ago was as follows: He weighed a sphere of 1.5 grams of silver, first free and then enclosed in a ball of lead of several kilograms. See Fig. 1. He figured that gravitation, having to traverse the lead in order to reach the silver, might be weakened somewhat and hence the silver weigh less. The result was negative, showing no variation in the weight of the silver greater than 1/100,000 of its weight, this being the limit of sensitiveness of the apparatus.

Laager's experiment may have confirmed the physicist's belief in the accuracy of the Newtonian law; but this is not necessarily correct. In fact, have we the right to believe that if the experiment were so modified as to make it more delicate and sensitive we should always obtain a negative result? Must we believe that if there were a means of determining the mass of the silver sphere when surrounded not by a few kilograms of lead (as in Laager's experiment), but by a mass like that of the earth, it must be unaltered? It seems to me not. And there remains the suspicion that the interior masses of such enormous agglomerations of matter as the earth and the sun may conceal more matter than appears to the astronomer. I should postulate a sort of progressive absorption of the force of gravitation. Considerations that would take too long to go fully into here make me hold that a certain flux of energy

(*Continued on page* 1190)

RICHARDSON'S POLYPHASE SLIDE RULE



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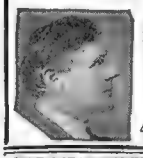

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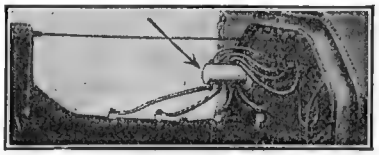

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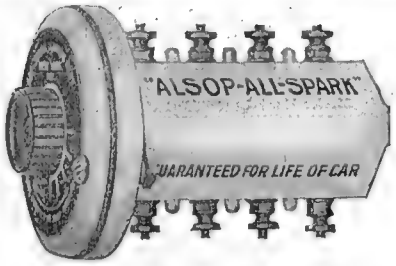

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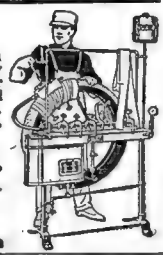

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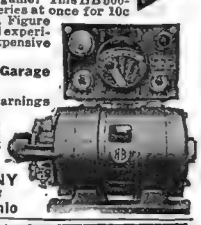

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New Researches in Gravitation

(*Continued from page* 1188)

is let loose from matter, and that this flux on coming into contact with other matter generates the force of attraction.

We may have a model of such a phenomenon by considering the phenomena of luminosity. A source which emits light appears enfeebled if there be matter intercepting the passage of the rays. Thus the rays of the sun reach us weakened by the air, or even more so still by water when observed from the bottom of the sea. Naturally, very thin layers of air or water do not weaken them, just as the force of gravitation is not weakened in Laager's experiment. The masses of the stars may be only apparent, since the force of attraction of their inner strata does not entirely issue forth. See Fig. 2. And each mass of matter would thus be characterized by a certain amount of *true mass* and another of *apparent mass.*

But, I may be asked, how do you explain that matter continues to emit such a flux of energy? Whence is it derived? For then the principle of conservation of energy is not respected, since you say that matter emits this flux indefinitely; hence the reserve of energy possest by matter must be infinite, which is absurd. To such an observation I answer by recalling the modern theories of corpuscular physics and the properties of radium. It is well known that this substance emits energy (electric and calorific), and that it is predicted that this phenomenon will continue for about 2,000 years. No more than that, for the radium is transformed. But the amount of energy that we may suppose to be emitted by any matter in a given time may be far less than that of radium; therefore, we must formulate our hypothesis by saying that any kind of matter must finally be transformed, just as in the case of radium. Therefore, it is to be held that while radium is transformed in 2,000 years, other matter requires millions or billions of years.

All this, however, leads us to another consequence. The energy emitted by matter and then absorbed must necessarily be transformed. Hence the formation of heat when notably large quantities of matter are in relations. We shall return to this towards the end.

Analytical Researches: All that precedes is hypothetical; it might be well to have an experimental verification of it. Now if the phenomenon of gravitational absorption is present in nature, it must be, to be found, preferably in the case of the larger agglomérations, the sun, for example. This star has a mean density of 1.41. One might make the hypothesis that this figure is only apparent and that its true density is actually somewhat greater.*

Is it possible to verify this?

I say it is; in fact, I have done it. I made use of a sensitive balance in a vacuum, each arm of which was laden with a leaden sphere of about 1.3 kilograms. One of the arms (that on the right) is situated at the center of a cylinder that can be filled with 104 kilograms of mercury. This adjustment is made with the greatest accuracy, so great that it may be held that the resultant action of the

*The problem is here treated by mathematics, by the author in his original paper, which tends to show that sun, for example, may have an apparent density, as known to astronomers, and a true density, having a value considerably greater. In other words the true density is not apparent by direct observation, but may be calculated from such experiments as those carried out by the author. He shows mathematically that the "true density" of the sun is 3.27 compared to its observed or "apparent density" of 1.41. The apparent density divided by the true density gives a ratio value of 0.433; or in other words the astronomically observed density of the sun is but .433 of the true density of that body.

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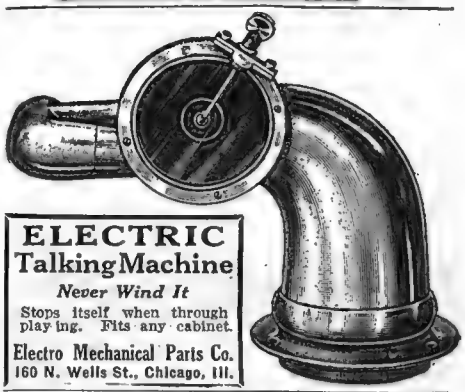

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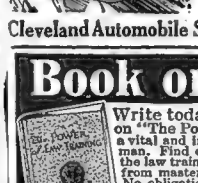

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mercury upon the ball of lead is exactly nothing. By observing with a microscope and scale, variations of weight as small as 1/1700 of a milligram can be detected in the balance. By causing the mercury to flow in and out of the cylindrical receptacle, and allowing for any causes of error into which I will not go here, I discover that the ball of lead diminishes in weight by about one billionth of its weight when it is surrounded by mercury. See Fig. 3. (It is not necessary to remark that the mercury does not touch the lead ball, this being adequately protected.)

This variation is actually due to absorption of the force of gravitation. In fact, the two chief accidental causes of error (calorific perturbations and asymmetry of mass) have been accurately eliminated. As to the first, I observe that the flowing in and out of the mercury can have no influence upon the temperature of the arm of the balance, since this is in a vacuum, protected by a thick metallic case covered with three layers of felt. Besides, the mercury, which is contained in suitable receptacles, cannot have a temperature differing from the balance by more than 1/10 of a degree more or less. The receptacles of the mercury are quite distant from the balance-arm. Finally, if the proven effect were due to such causes of error, it would not show itself always with the same sign. The four or five thousand observations of oscillations all agree as to sign. Asymmetry of mass might have caused a false effect if it had depended, for example, upon an error of about 4 m/m in the adjustment of the mercury to the ball of lead. But this adjustment was made with a precision of from one to two tenths of a m/m; hence such an error is impossible.

The proven variation in weight permits us to determine with fair approximation the value of h, the constant of amortization by unity of mean thickness and by unity of density. Thus we have $h = 6.18 .10^{-12}$. Knowing h, it has been possible to determine the relative density values for the sun, since its apparent density and the diameter (7.10^{10} cm, or 700,000 kilometers) are known; and finally, its true density, which remains fixt at 3.27, *that is, more than double the apparent or astronomic density.*

Unless there be causes of error that I do not know, my theory has thus a brilliant confirmation from experiment. It may be that my results are only approximate, but I hold that the new phenomenon of gravitational absorption really exists.

The experiment performed by me is exceedingly delicate; to be able with absolute certainty to exclude every possibility of concealed error, it will be necessary to repeat it under conditions in which the effect will be more conspicuous. For this purpose I have begun the construction, here in the Politecnico (at Turin) of two strong swinging armatures each of which will support five tons of lead ingots. I expect to get from this apparatus an effect about ten times as great as that already found.

In addition to this, in conformity with all the theory I have expounded, I am preparing an experimental apparatus to ascertain if matter is really heated in consequence of the earth's gravitational flux.

I shall report the results of both experiments in due time. But in the meantime I cannot resist the temptation to apply the foregoing results to the interpretation of celestial phenomena.

A first application has been made implicitly with the assertion that the sun's true density is double its apparent density. So in certain cases we could determine the true density of other celestial bodies. Those of the planets and their satellites would certainly differ very little from their apparent density; while in the case of the other suns of the universe, if the determination were possible, the differences would be quite noteworthy.

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Or suppose you are waylaid on a lonely road or deserted street. Unless you know how to overcome your opponent, and escape, it is very likely that your friends will find you lying in the road, possibly unconscious—another victim of attack, one who could have saved himself had he learned the valuable lesson of self-defense.

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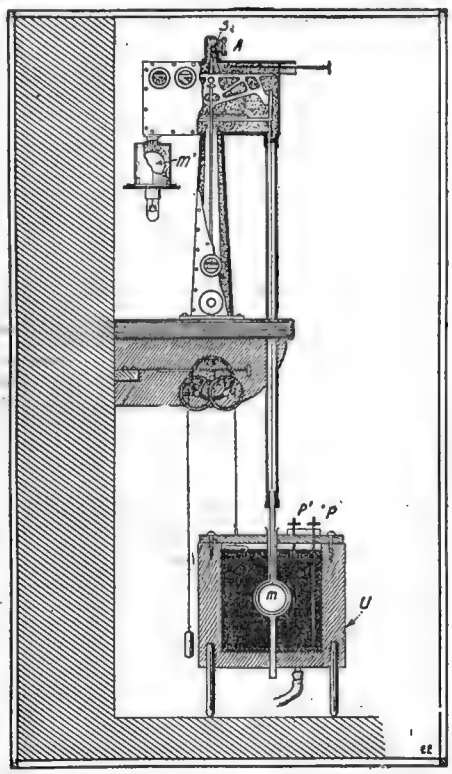
But the most important consequences which the present theories would have refer to the formation of the heat of the stars. Altho up to now I have not executed any experimental control of the following hypothesis, I hold it to be highly probable. The stars would generate, continuously and spontaneously, new quantities of heat, and this the more notably the greater their true mass. Reasons upon which I will not dwell make me hold that the quantity of heat developed by a star in a determined time is proportional to the square of its true mass. This hypothesis finds confirmation in a comparison of the sun's heat with that proper to the earth.

I do not exclude, however, that in some or in many cases the heat of the stars may not depend at least in part, upon facts corresponding to the old theories: heat occasioned by cataclysms that took place at more or less remote epochs, or due to Helmholtz's contraction. But, according to my ideas, these causes could only add their effects to the new cause that I have suggested.

As I have already said, both the hypothesis of gravitational absorption and the other of the emission of heat would lead us to the consequence of a progressive transformation of matter. Perhaps this is degrading in its energy; how and for how long it is not yet possible to say. Certainly, if such degradation exists it corresponds to a slow transformation of matter itself. Perhaps it is passing from states of complex atomic agglomeration to others more simple, as take place in the case of radium. But this has little importance for us.

What, instead, is most important is the discovery of a new cause for the generation of heat by the stars. This enables us to conciliate the existing controversy between the physicists and astronomers on the one hand and the geologists and biologists on the other. In other words, the theories I have set forth would contribute in a most important way to the interpretation of the life of the stars in general and of our life in particular.

Lecture delivered by Prof. Quirino Majorana, at the Società di Fisica, Turin, December 4, 1919.



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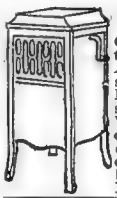

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The Positions of Atoms in Metals

By Dr. A. W. HULL, Ph.D.

(*Continued from page* 1134)

compound, containing only two kinds of atoms, whose structure is so simple that it cannot be misunderstood. Examples of this type will be included in the following discussion.

I have referred to the location of atoms as next to last in the series of atomic discoveries. For in order to complete the picture, one more discovery is necessary, *viz., the shape and size of the atom.* An excellent beginning in this direction has already been made by Langmuir whose theory of atomic structure predicts the shapes and relative sizes of all the atoms, and gives strong chemical evidence in favor of these predictions. The author hopes soon to be able to add the evidence of X-ray measurements, which will determine not only the shape but the exact size of the atoms, that is, the positions of the electrons in the atoms.

Summary of Results. The most striking result of these investigations is the extreme simplicity of arrangement of atoms in common metals. Among the metals thus far examined only three types of atomic arrangement are found, and these are, with one exception, the three simplest geometrical arrangements known. The simplest arrangement of all is not found among metals, but is characteristic of salts, which are composed of equal numbers of positive and negative ions.

The most common arrangement in metals is the *face-centered cubic* arrangement shown in Fig. 1. This is also the most important since most of the useful metals,—*e.g.,* aluminium, nickel, cobalt, copper, silver, platinum, gold,—have this arrangement of atoms. Perhaps it would be better to say that those substances are most useful as metals which have this arrangement, since, as will be shown later, their ductility is due largely to this arrangement.

The face-centered cubic arrangement is obtained by dividing the space occupied by a single crystal or "grain" of metal up into a system of equal, closely packed cubes (Fig. 1) and placing an atom at each cube corner and at the center of each cube face. All the atoms in this arrangement, both corner and face atoms, are similarly situated as regards symmetry and relation to neighbors. Each atom is surrounded by twelve others, all equidistant and exactly similarly situated for every atom. It is this high degree of symmetry, combined with the close packing, that makes substances of this type so ductile.

The Measuring Machine. The determination of these atomic arrangements requires the measurement, in as many different directions as possible, of the distance between consecutive *planes of atoms.* The arrangement of atoms, whatever it may be, is assumed to be a regular one which repeats itself thruout the crystal. This assumption can be checked by the result. Thru such an arrangement a system of equidistant parallel planes can be drawn in any direction whatever so as to pass thru all the atoms. In most directions, these planes will be very close together and sparsely settled with atoms. In a few particular directions, however, they will be far apart and densely populated. These are the directions of easy cleavage and gliding. It is these densely populated planes whose distances apart are measured.

The original measuring machine, by which the pioneer measurements were made, was a special form of *spectrometer.* It has been simply and charmingly described by its inventors in a book worth reading. The measurements described in

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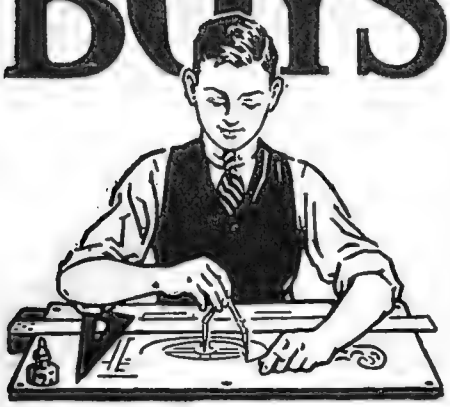

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this paper were made with a modified form of Bragg machine. The original machine was applicable only to large perfect crystals, required careful manipulation, and was subject to serious error unless the crystals were very perfect and the number of observations large. The author's modification is free from these errors, requires but one simple observation, and is applicable to all substances which are crystalline, *i.e.*, all in which there is any arrangement to measure.

The complete machine is shown in Fig. 2. It consists of a small transformer (or other source of high potential) capable of supplying 1 kw. at about 30,000 peak volts; a Coolidge X-Ray tube, X; a thin sheet of properly chosen material, f, serving as filter; a pair of slits, s_1 and s_2, in metal sheets, to limit the beam of X-rays; a tiny glass tube, T, containing the powdered substance to be measured; and a photographic plate or strip of film bent in arc of circle, F. The operation consists in filling the glass tube with a few milligrams of the substance to be analyzed, powdered as finely as possible; "loading" the photographic film holder; exposing over night to X-rays at 30,000 peak volts and as many milliamperes as the tube will carry safely without watching (a maximum exposure of 300 milliampere hours) and developing the film.

A typical photograph is shown in Fig. 3, and this is a photograph of aluminum filings, taken with a plate and very short slits, so that the trace of the direct beam in the center of the plate is a circular spot. The circles and lines are due to the "reflection" of the X-rays by the tiny crystals in the tube, as will be described later. The distances of these circles or lines from the central line on the film are nearly proportional, inversely, to the distances between the planes of atoms, and from them these atomic distances can be easily and quickly calculated.

The Measuring Rod. The measuring rod by which these atomic distances are measured is the wave-length of a particular X-ray.

The possibility of measuring the dimensions of any physical body depends, primarily, upon the possession of a measuring rod of length comparable with the dimensions to be measured. Thus, the discovery and calibration of wave-lengths of visible light opened up a whole new field of measurements, comparable in length with this new measuring rod, such as the thickness of films, imperfection of polished surfaces, displacement of vibrating membranes, increase in length due to thermal expansion, etc. In the same way, the discovery that X-rays are of the same nature as light, and the isolation and calibration of X-ray wavelengths, opened up a vast new field of measurements of dimensions comparable with the wavelength of X-rays; *viz.*, atomic dimensions.

We are accustomed to think of the measurement of things too large or too small to see and touch as necessarily very rough and approximate. It is somewhat of a surprise, therefore, to note that the only measurements accurate enough to justify the use of eight-place logarithm tables are those of astronomy; that wave-lengths of light are measured to 1 part in 10,000,000; and that the wave-lengths of X-rays, and by means of it, the distances between atoms, can easily be measured to 1 part in 100,000.

The spectrum of X-rays is exactly like that of *visible light* except that the wavelengths are shorter. It consists of bright lines superimposed upon a continuous spectrum. The wave-lengths in the X-ray spectrum depend upon anode material and voltage in exactly the same way that the wave-lengths in the visible spectrum depend upon incandescent material and temperature. And just as it is possible to obtain nearly monochromatic yellow light by putting salt in a flame under proper conditions, so by running an X-ray tube

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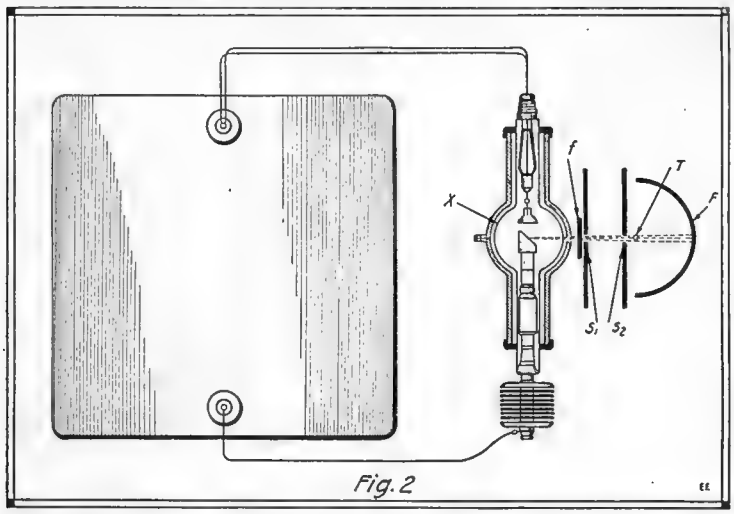

Fig. 2

Fig. 2. Above, Shows the Unique X-Ray Apparatus, Which Was Employed for the Purpose of Photographing the Atomic Structure of Metals.

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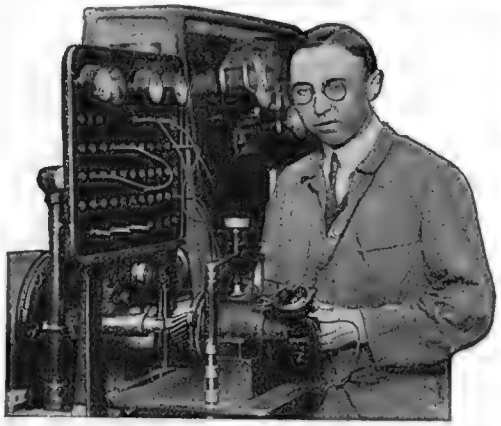

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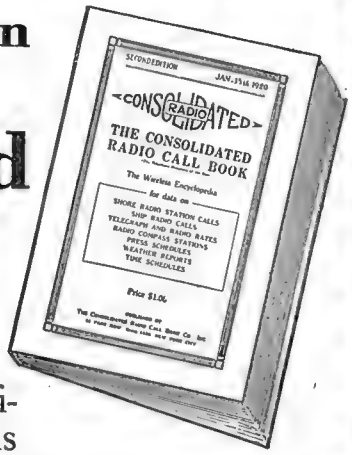

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distances. If, as shown in the original paper, the X-rays are made monochromatic by proper voltage and filtering, then as the crystal is rotated a series of intense reflections will be observed at angles whose sines are in the ratio of 1 : 2 : 3, etc., corresponding to successive integral values of n in Eq. 1. If a new face is ground on the crystal at an angle to the first, and exposed to the rays in the same way, another similar series of reflections will be observed, at different angles, corresponding to the different distance (d, Eq. 1) between the planes parallel to this new face. The process of analyzing a crystal consists in observing these reflections from as many faces as possible, and calculating, from Eq. 1, the distance between the planes parallel to them. When a single crystal is used this requires many observations. The work is greatly simplified by using a powder, in which all possible orientations are represented at the same time by one or more of the tiny crystals, and photographing simultaneously the reflections from all these little crystals. This is the method sketched in Fig. 6 of the original paper. It might be expected that the number of lines in these patterns would be infinite, since there is an infinite number of different possible planes in any crystal. The reflections from most of these planes, however, come at angles whose sines are greater than 1 (as is evident from equation [1] when d is small), and which therefore do not exist.

The analysis of these photographs is very simple in the case of simple substances, like pure metals. It consists in finding, by successive trials, an arrangement of atoms whose planar spacings, beginning with the planes farthest apart and skipping none, exactly fit the observed pattern of lines. The calculation of the planar spacings for all the important planes is not difficult, and with simple substances but few trials are necessary.

The electrical conductivity of metals depends on the ability of electrons to move between the atoms. A discussion of this without a better knowledge of the shape and size of atoms would be premature. It can be seen at once, however, why "ion salts" and crystals like diamond are non-conductors. In each of these arrangements the electrons in the atoms are in complete groups of eight, which is such a stable arrangement that large forces (corresponding to the dielectric strength of the substance) are required to remove them. The atoms of metals, on the other hand, have extra electrons which cannot find places in these stable shells, and are therefore "free" to move from atom to atom.

MAGNETIC PROPERTIES.

It is well known that the ferro-magnetism of iron is not a specific property of the iron atom, since iron in solution and in compounds is in general not ferro-magnetic. The ferro-magnetism must depend, not only on the nature of the atoms, but on the way in which they are grouped together. It might have been anticipated, therefore, that the cause of ferro-magnetism was the *centered cubic arrangement* which is characteristic of iron. A glance at the results tabulated so far shows that this is not the case. Nickel, which is ferro-magnetic, has a face-centered cubic arrangement, like copper. Cobalt is sometimes like copper, sometimes like magnesium. Neither is like iron. Chromium, on the other hand, which is not ferro-magnetic, has a centered cubic arrangement like iron. Manganese has not yet been obtained sufficiently pure to determine its arrangement. It is evident, therefore, that while the centered cubic arrangement may be favorable to ferro-magnetism, and may make iron more magnetic than cobalt and nickel, it is not the principal or even an essential factor.

In this Department we publish such matter as is of interest to inventors and particularly to those who are in doubt as to certain Patent Phases. Regular inquiries addrest to "Patent Advice" cannot be answered by mail free of charge. Such inquiries are publisht here for the benefit of all readers. If the idea is thought to be of importance, we make it a rule not to divulge all details, in order to protect the inventor as far as it is possible to do so.

Should advice be desired by mail a nominal charge of $1.00 is made for each question. Sketches and descriptions must be clear and explicit. Only one side of sheet should be written on.

SPECIAL NOTICE!

Of late we have received so many letters from our correspondents regarding patent advice, that it has been quite impossible to publish all of them. Altho printed in the smallest type possible, we cannot accommodate more than ten or twelve answers a month. At the present time we are about four months behind. Of course, if our correspondents have time, no harm is done! We would, however, advise that if a quicker answer is wanted, correspondents should avail themselves of our special service, as per the notice printed at the head of this column.

All letters are answered in turn as they come into this office, and for this reason it will be understood why it takes so long for an answer to be publisht. Will correspondents please bear this in mind?—EDITOR.

Automobile Appliance.

(375) Mr. Maurice Goldberg, of St. Paul, Minn., writes:

Kindly tell me if I can obtain a patent on the following:

(1) A hole is cut out of the mica sheet in automobile shades and a flap sewed on, so that when shades are down and the driver wishes to put out his hand telling which way he is going to turn, he can shove his hand thru the hole in the curtain, the flap being pushed outward, and when the hand is taken in, the flap falls back. The flap should be made a little larger than the opening, which will be about six inches in diameter, round or square, and set a little to the front as the hand naturally reaches a trifle forward. Flap to be placed on each side of the driver.

A. We doubt whether a device of this kind would find much favor with automobilists. One of the troubles immediately would be that the flap in question would flap violently against the sides of the automobile, due to the wind action, producing an irritating noise. The mechanical pointers on the market at the present time solve the problem better.

(2) An attachment to a talking machine whereby the reproducer and needle are lifted up at the end of the record and placed at the beginning, keeping this up indefinitely until the motor is unwound or some person stops it.

A. There is nothing new about this invention. Any modern phonograph shop will sell you an appliance that will do what you claim for your device. There are several good devices of this kind on the market; the best one being known as the "Encore." This will reset the tone arm at the beginning of the record as soon as it has reached the end. It will continue playing the same record over and over, 'till the machine runs down.

(3) A gyroscope of suitable dimensions geared or belted or in some manner with the shaft of the engine or motor of an auto to steady it when going around turns, speeding along rough roads, etc.

A. We doubt whether this scheme would be feasible in practice, besides some automobilists have large fly wheels which acts as a gyroscope, in a small way. We doubt whether automobilists would pay an increased price for a gyroscope, just to keep a car from skidding around the corner.

Hard Copper.

(376) C. E. Nichols, of West Philadelphia, Pa., writes:

I firmly believe I have discovered the key to hardening copper. I have been a reader of the ELECTRICAL EXPERIMENTER for a long while.

Will you please refer me to some one who will help me to commercialize and develop this process and determine the value.

A. If you really have invented a way of hardening copper, we can say truly that you have struck not a copper mine, but a veritable gold mine. We have heard much of hardening copper recently, but most of it turned out to be some sort of bronze or copper mixed with other metals to harden the copper,—in other words, an alloy.

We have as yet not seen copper that has actually any degree of hardness as compared to good bronze. Any large companies, such as you will find in your city, we think would be glad to take up the matter with you if you have something really worth while.

Auto Device.

(377) Stephen Juva, of Lawrence, Mass., writes:

Please tell me if a patent can be obtained on an automatic power device on an automobile. The device is such that when the auto gets to a hill the device inclines and lets in more "gas," and when going down hill it inclines to reduce the supply of "gas," according to the grade of the deline.

A. This seems to be an excellent idea and we know there would be a good market if such an attachment could be produced at a reasonable cost. We think many automobilists would install it. If you have actually tried it out, and know it works, we would advise you to get in touch with a patent attorney.

Chemical Hood.

(378) Mr. Morton Bermann, of Newark, N. J. writes:

Please let me know whether or not a patent can be obtained on an adjustable hood for chemical laboratories.

It is to be much the same as the ones now in use, excepting that it can be adjusted to absorb gases from any part of the work bench.

A. There certainly is a great demand for a hood of this kind, if it is as you say. We are certain that most factories which have much to do with obnoxious fumes, would be glad to buy a device of this kind. It would be advisable for you to get in touch with a patent attorney if you know for sure that the device works well.

Valve.

(379) David C. Bramley, Shamokin, Pa., writes us as follows:

"I am interested in some of your answers in *Patent Advice* section and would like to ask you a question regarding my patent or improvement. I am employed at one of the coal companies as pumpman which includes much pipe fitting of all sizes, and have occasion to change valves when they eat thru the seatings such as, namely, Lukenheimer, Globe, and many others on the market today. I find during the 15 years' experience with them they last but a short time, unless continually opened or closed, the valve is then removed which causes at times a great deal of trouble, labor, time and expense. Now I have a method of repairing those valves in five minutes so that it won't be necessary to disconnect or throw them away, and they can be repaired time and again less one-third the cost of the valves, and again they need not be made of brass, still

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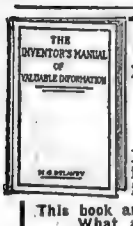

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further reducing cost. Will those valve concerns allow me to use one of their valves to produce the improvement? How can I locate their address? It is a simple construction and I think would be valuable to many as I have seen many shipped away considered useless on this slight account. I have tested the improvement under 100 lbs. steam and 250 lbs. water pressure per square inch."

A. We can only say that if you really have such an improvement, we are quite certain that you will have no trouble in making a large amount of money out of the invention. If this idea has been tested out and found to work, we would advise you to get in touch with a patent attorney. To use the improvement in the patented valves of the firms you mention would require their permission, we think.

The Amateur Magician

By JOSEPH KRAUS

(*Continued from page* 1140)

the gruff reply. Then, addressing me, "Here, you hold her, while I talk to her, or place her on the table if you desire, she's too desperate for me." Continuing his conversation with the skull, he added, "Do anything?"—"I would like to do you," came back the snappy retort.

Well, that was enough. I wanted to see how it was done. So going over to the side and examining the wires which held up the plate, I was surprised to see the professor remove the glass shelf and proceed to question the skull and receive just as many answers to his queries as he had received before.

"Come, don't keep me in suspense!" I exclaimed. "How is it done, that is just what I want."

"Well," he said, "very simple, nothing to it, and I am really surprised that more magicians do not carry a device of this nature around with their usual outfit."

Removing the top portion of the skull, he showed me simply a coil of wire arranged so as to fit snugly inside the vault and consisting of 300 turns of No. 38 enameled magnet wire connected to a telephone receiver having a horn attached to the hard rubber cap. Looking at it I could see no wire coming from it and finally an idea beamed!!! "INDUCTION?" I asked.

"Exactly," he exclaimed, "and very simple at that. You were examining the glass shelf and the wires leading to it and like everyone else discovered nothing, because there is nothing there to discover. The entire trick rests not in the glass shelf but in the table under it." Lifting this up and turning it over, he showed me a microphone attached to a large diafram. "That is the communicating phone by means of which my assistant in the other room knows of the skull's affairs."

This microphone was connected to two wires which ran down to two metallic floor connectors and in series with a battery and a pair of phones to his assistant in another room. Two other wires running up the leg of the table terminated in a coil, about 1½ feet in diameter, consisting of 300 turns of No. 22 D. C. C. magnet wire. To all appearances this was all there was to the apparatus, but following the professor from the room, I came upon the *operator-in-chief* of the device. There he sat, with a pair of phones clapt over his ears enjoying a hearty laugh.

A telephone transmitter was fastened to the table and this in series with the typical audion amplifier. This is how he managed to get such a powerful voice, the professor explained. You see, even the finest telephone transmitter is capable of delivering but a very small amount of current. In order, therefore, to get sufficient induction in the coil inside the skull, at least enough to make the sound emitted by the 75 ohm loud-talker sonorous enough to be heard, we must employ an amplifying circuit. The ordinary audion bulb is used and connected directly with the small induction

(*Continued on page* 1210)

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Practical Chemical Experiments

By PROF. FLOYD L. DARROW

(*Continued from page* 1143)

FREEZING WATER

In a small flask or beaker place 15 c.c. of carbon disulfid and 5 c.c. of water. The water being much lighter than the carbon disulfid floats on the surface of the latter. Standing by an open window or in a good draft blow into the carbon disulfid thru a bent glass tube. The rapid evaporation of the carbon disulfid produces a temperature as low as 15 *degrees below zero* and the water quickly freezes.

The experiment may be varied by placing the beaker containing only carbon disulfid on a block of wood with a little water between the beaker and the wood. Upon blowing thru the liquid in the beaker the wood and beaker are quickly frozen together.

THE BROMINE GUN

Fit a hydrogen generator having a side neck with a stopper and dropping funnel. In the bottom of the generator place a little red phosphorus and moisten with water. In the dropping funnel place a little liquid bromine. See Fig. 8. Upon opening the stopcock of the funnel and allowing a few drops of bromine to fall upon the phosphorus a flash of light fills the generator and a puff of vapor issues from the side neck. The operation may be repeated as often as desired.

The bromine and phosphorus unite to form the unstable compound-phosphorus bromid, and this is decomposed by the water forming hydrobromic acid which issues from the generator.

SMOKE RINGS

Arrange two bottles having their bottoms removed as shown in the diagram.

To cut off the bottom of a bottle tie around it a hemp string soaked in kerosene. Ignite the string and when it has ceased burning, gently strike the bottle near the bottom. It will break along the line of the string.

With the pinch cock between the bottles closed, fill the upper bottle with hydrochloric acid gas as by downward displacement and the lower bottle with ammonia gas by upward displacement. The hydrochloric acid is generated by heating sodium chlorid and concentrated sulfuric acid in a Florence flask fitted with a stopper, thistle tube and delivery tube. The ammonia gas may be obtained by heating in a flask with delivery tube some strong ammonia water.

When the two bottles are full, open the pinchcock and the ammonia will rise into the bottle of hydrochloric acid forming a series of smoke rings. See Fig. 9.

POURING THE NATIONAL COLORS FROM A PITCHER OF WATER

Fill a pitcher with clear water and add a few cubic centimeters of ferric chlorid solution, stirring well. Place three tumblers on the table. In the first place a few drops of a solution of ammonium sulphocyanate. Leave the second empty. In the third place a few drops of potassium ferrocyanid solution. Now pour from the pitcher into the tumblers in the above order and the national colors—Red, White and Blue will appear!

(*The next installment will appear in the April Issue.*)

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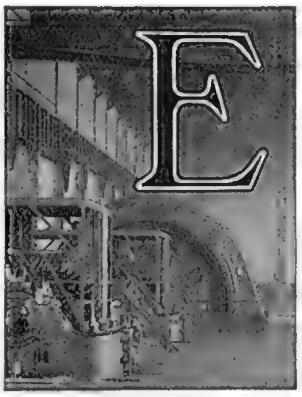

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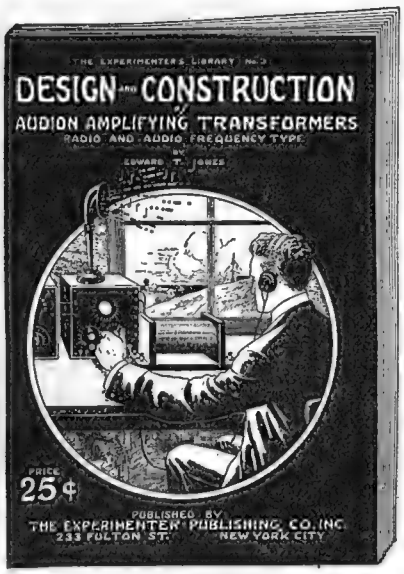

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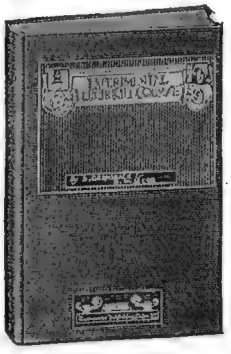

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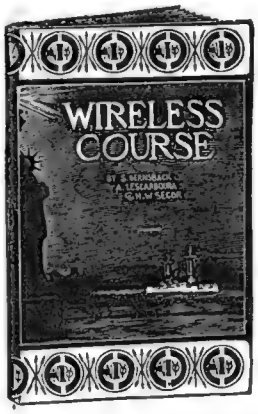

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Gaseous Telephone Transmitters

By RICHARD A. ENGLER

(*Continued from page* 1155)

Fig. 7 illustrates how the throttling of the gas or vapor path may be accomplisht in one way by purely mechanical means. A mercury arc tube is shown wherein are placed several perforated insulating discs of light-weight material. The tube can be mounted upon a sounding board or otherwise vibrated. The obstructing discs can move freely because of the vacuum within which they operate; disregarding the vapor pressure.

Both anode and cathode should be of mercury in this case so that when the mercury condenses more on one side of the obstructing means than on the other, the current can be reversed to carry the mercury to the other side again.

When the sounding board is vibrated, the tube vibrates, as do the light-weight insulating discs also, with the result that the perforations in the discs close more or less and thus throttle more or less the vapor path and therefore throttle the current flow more or less. The discs are mounted in the tube so that they cannot rotate around their axes and also so that they do not close each other's perforations completely by the vibration. The two discs shown in the center fit loosely between the two end ones and also loosely between the walls of the tube, while the two end discs fit snugly in the tube, thus the two central discs only vibrate.

A method of employing dynamic electricity as the throttling means is shown in Fig. 8. Here the well-known "Audion" and circuit are employed and the grid is vibrated *into* and *out of* the ion stream more or less by the exterior vibrating diafram and magnet. The grid may also be caused to approach and recede from the filament or plate or otherwise moved while being completely *immersed* in the ion stream. The grid current will also be varied and its effects can be added to the plate circuit effects. The grid battery may flow with or against the plate current and ion stream.

A Bell magneto-electric transmitter may provide current to the grid circuit of an "Audion" and thus obtain a very neat form of transmitter by the combination.

The movable discs in Fig. 7 and grid in Fig. 8 may be mechanically connected thru the glass wall to the diafram instead of being operated by magnetic means, altho the latter is more desirable from a constructive and operative point of view.*

Now let us take a battery, a primary coil, two electrodes and an air space between the two electrodes and all in series. Then by means of X-rays let us ionize the air space and make it conductive. Current from the battery then flows across the air space. This air space may then be used not only as a transmitter, but in many ways like the mercury vapor arc and the "Audion" are used. The ionization of the air space may be local or not. When not local, the ionized air can be brought between the electrodes as a stream of air which has past an X-ray field, because air keeps its ionization for some time after passing thru an X-ray field. A manometer may be used to inject ionized air between the electrodes.

*The glass wall of the tube itself may be the diafram in such a case.

When a magnet is used as the throttling or varying means, the tube can be replaced with less expense and more ease than where mechanical throttling or varying means or where mechanical connections are employed because in the latter cases the operating means are within the tube or part of the tube.

(*Continued on page* 1202)

Fleming Pat. No. 803684
De Forest Pat. Nos. 841387-879532

A WARNING

to Manufacturers
Importers
Dealers
Jobbers
Agents
Amateurs
Purchasers
Users of

Vacuum Tubes

The Marconi V. T. Patent is Basic

United States Letters Patent to Fleming, No. 803,684, November 7, 1905, has been held to be valid by Judge Mayer of the United States District Court for the Southern District of New York, and by the United States Circuit Court of Appeals for the Second Circuit.

It is a basic patent and controls broadly all vacuum tubes used as detectors, amplifiers or oscillions in radio work.

No one is authorized to make, sell, import or use such tubes for radio purposes, other than the owners of the patent and licensees thereunder. Any others making, selling, importing or using them alone or in combination with other devices, infringe upon the Fleming patent and are liable to a suit for injunction, damages and profits. And they will be prosecuted.

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Do not take chances by making, importing, selling, purchasing or using vacuum tubes for radio purposes not licensed under the Fleming patent. By selling, purchasing or using licensed tubes for radio purposes you secure protection under the Fleming patent and avoid the risk of litigation for infringement thereof.

This warning is given so that the trade and public may know the facts and be governed accordingly.

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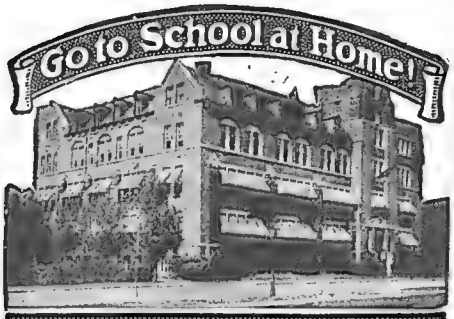

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Gaseous Telephone Transmitters

(*Continued from page* 1200)

If a mouthpiece is placed near this ionized air space as shown in Fig. 9, a very perfect form of transmitter is possible, because the rarefaction and condensation of the ionized air causes a variation in the current flowing thru the air space. Ionized air has never been used as herein described and should be of great value in the art.

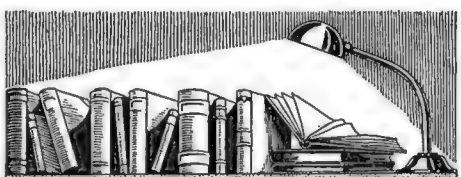
Other gases confined in vessels may be substituted for the air space. Air is more powerfully ionized by X-rays, however, than other gases; and devices using such an ionized air space are free from the disadvantages peculiar to devices which require a vacuum tube. X-rays do not affect a vacuous space nearly so much as air and some other gases.

When a stream of ionized air is used and such throttling means used as in Fig. 7, then not only is the electric current varied, but also the air current, and this latter variation of pressure may be utilized to operate another transmitter.

Suppose the space between the electrodes in Fig. 9 should be somewhat greater and the X-rays from an X-ray generator are projected from one electrode to the other, then a high tension current would traverse the space and a kind of wireless transmission of power is available, the earth in this case being used as a return path. X-rays have been detected as far away as 60 feet in ordinary apparatus years ago.

I believe this is enough to show what a useful and interesting field *gas and vapor paths* offer in the way of transmitters; and I believe that many suggestions will be induced in other minds by this disclosure in such a rich and fertile field. I may say, therefore, that I have taken necessary precautions long ago to well protect the entire field I have opened.

It seems peculiar that such simple and effective transmitters have not before made their appearance in view of the great activity of late in gaseous devices of all kinds.



BOOK REVIEW

DESIGN AND CONSTRUCTION OF AUDION AMPLIFYING TRANSFORMERS—RADIO AND AUDIO-FREQUENCY TYPE. By Edward T. Jones. Cardboard cover, 16 pages, 12 illustrations, size 5⅛x7¼ inches. Publisht by Experimenter Publishing Co., of New York.

This book deals with the construction of audion amplifying transformers of the air core type for radio frequencies, and is a most timely and important subject in view of the great strides which the audion has taken in recent years.

Amplifiers are essential and their prices generally are exorbitant for the real good kind. Mr. Jones, who readers of both this magazine and *Radio Amateur News* know, to be a celebrated writer and authority on the subject of radio, has given clearly and concisely the essentials of the construction of these transformers so that a boy 12 years old can understand them and follow the necessary details required in constructing them.

With but two steps or stages of amplification, a resultant of 400 times the original is obtained, and stations heretofore unheard, come bellowing in on the ether. The book deals with the subject as thoro as any amateurs who know nothing at all about the construction of such transformers may desire. No one then need question his ability to construct one suitable for any work. In addition, hook-ups are given, together with dimensions and constructional data for a small capacity condenser.

Mr. Jones has succeeded in bringing these devices into the hands of all "Radio-bugs" at a surprisingly nominal cost, particularly those who handle audions in any way whatsoever.

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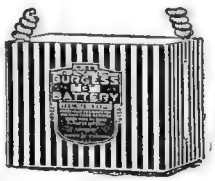

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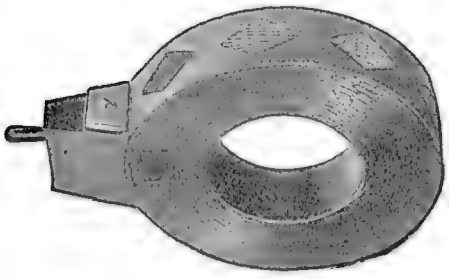

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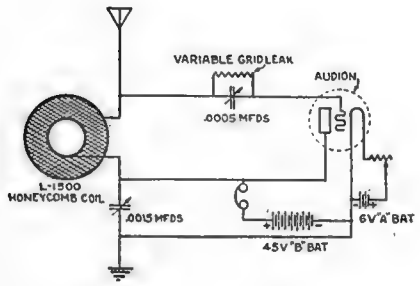

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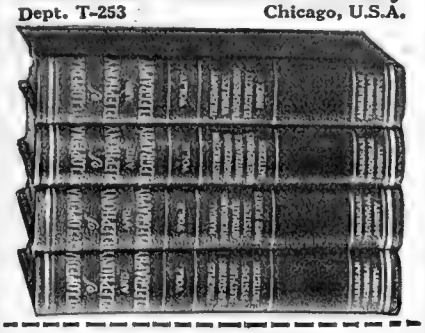

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Vacuum Tube Amplification

By PIERRE H. BOUCHERON

(*Continued from page* 1159)

a signal amplification 10^{12} times greater than a single VT circuit! As will be noted, VT No. 1, No. 2 and No. 3 are for the purpose of amplifying the received signals at their *radio* frequencies thru radio frequency amplifying transformers T1, T2 and T3. VT No. 4 is made to act as a *rectifying detector* by introducing a grid condenser GC, shunted by a grid leak resistance GL. Vt No. 5 and No. 6 amplify the resultant *audio* frequency signals which are in turn intercepted in the telephone receivers. Another important operating factor to be noted in both Fig. 3 and Fig. 4 is the use of a common "A" and a common "B" battery. The "A" battery furnishes filament current to all combined tubes (provided, of course, that all tubes employed are of the one standard type), properly regulated thru the use of the common rheostat R of about 5 to 10 ohms variable resistance; while the "B" battery supplies the necessary plate potential to all tubes used. It is sometimes advisable, particularly for experimenters, to make the plate "B" battery variable in potential by means of individual cell tapping. This "common battery" method effects a considerable saving of additional batteries as well as space. It is, of course, evident that the "A" battery must be of sufficient ampere-hour capacity to properly take care of all tubes at one time.

A FEW WORDS ABOUT AMPLIFYING TRANSFORMERS.

As explained before, *radio* frequency transformers are employed in amplification *before the detection and rectification* of the incoming signals, while *audio* frequency transformers are used to amplify the rectified audio or comparatively low frequency. Contrary to the belief of some, an open air-core transformer *is not necessarily* a radio frequency one, and likewise an iron-core transformer *is not necessarily* confined to audio frequency amplification. As a matter of fact, both air-core and iron-core types are used for *either* purpose, providing they are suitably wound. In general practise, the design of a transformer must be such as to meet the characteristics of the tubes employed, either at radio or audio frequencies. That is to say, the ratio between the primary and the secondary winding of an amplifying transformer must be such that the secondary will give a maximum potential to the grid circuit of the next tube in cascade.

Consistent with that which has previously been said, it is therefore up to the experimenter to decide which method of amplification is best suited to his need before securing either *radio* or *audio* frequency couplers or transformers. For instance, if his means are limited, he may prefer to first experiment with grafite rod couplers, which, of course, are much less expensive than the transformers and will give fairly good results, particularly with radio frequencies. If he wishes, however, to construct an efficient two-stage amplifier for the purpose of amplifying previously detected signals, he will want to use the popular, iron-core audio frequency transformers. Any of the transformers mentioned here may be designed and constructed by the average amateur, but unless he has access to a lathe or a winding machine, the job had better be left to the regular manufacturer. Since audio frequency amplification is probably the most popular method at present among amateurs, atten-

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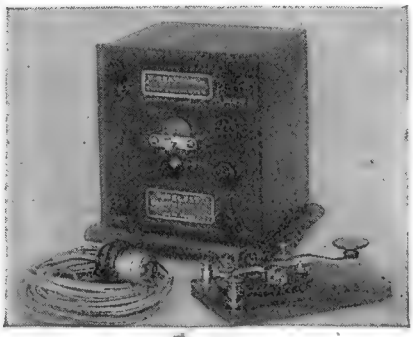

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tion is invited to a very compact and much used laminated iron-core audio frequency transformer and which may be had for a few dollars. Of course, there is a great deal of pleasure to be had in building one's own apparatus, so if you have the facilities, why, "go to it."

Electroscope for Radio-Activity

By FRANK M. GENTRY

(*Continued from page* 1146)

A brass rod, K, 3/16" in diameter and 5¼" long, was threaded on one end for a distance of 3/16". The other extremity was cut with a hack-saw to a depth of ¼", X, Fig. 2. A ¾" brass ball, L, was drilled and tapt to take the threaded end of the rod. The strip, Q, Fig. 2, was cut from 1/32" brass sheeting the shape shown at N, Fig. 1. The strip was 3½" long and ¼" wide. For a distance of ¼" from the top it was narrowed to 3/16" in width. The projecting pieces on one side of the strip were ¼" wide and 5/16" long. They were bent at right angles to the strip along the dotted lines shown in Fig. 1 so as to form a means of attaching the scale to the electroscope, R and S, Fig. 2. The narrow end of the strip, Q, was then inserted in the slit provided in one extremity of the rod, K, and soldered in place as shown at X. When the superfluous solder was removed, the brass was polisht with pumice stone.

A piece of stiff white cardboard, V, was cut as the sector, embracing an angle of 45°, of a circle whose radius was 3". The arc was divided into a scale of degrees for the purpose of measuring the angle of divergence.

The rod, K, was roughened for a small distance ¾" above where the brass strip was soldered so that the insulation, M, would hold it in place. The rod was then placed in the center of the hole in the top, O, Fig. 1, and embedded in molten sealing-wax. The scale, V, was fastened to the strips, S and R, provided for the purpose.

Two circular discs, F and E, Fig. 2, 4" in diameter, were cut from 1/16" brass or copper sheeting. Two knurled battery thumb nuts, G and D, were then soldered in the center of each disc. These formed the condensing plates of the electroscope.

A 5/32" brass rod was bent L-shape so that one arm was 1¼" long and the other was 4¼" long, C, Fig. 2. Each end of the rod was threaded to a distance of 3/16". One of the condensing plates was screwed to the short end of the rod while the other end was secured to one side of the container. 1½" from the top, by means of nuts, B, Fig. 2. Another piece of 5/32" brass rod was bent similar to the rod, C, except that the long arm was 5½", H, Fig. 2. When the threading was completed, the remaining condensing plate was screwed to the short arm while a binding post, I, Fig. 2, which had previously had a 7/32" hole drilled in its face, was fitted to the long arm. The rods and condensing plates were polisht with pumice stone as before.

The most difficult operation of all was then encountered; that of cutting and attaching the gold-leaf. Several sheets of gold foil were obtained at the glazier's and cut into strips ¼" x 3¼" while sandwiched between layers of paper. The strip, Q, was moistened at T for a distance of ¼" with a weak solution of gelatine in warm water which served as an adhesive in affixing the leaf. The fact that the gold foil could not be touched by the hands and that it could only be handled by some

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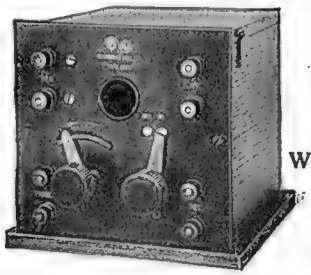

Price, $17.00 Without Tube

Audion Control Cabinet Type RORH

contains the grid condenser, grid leak, filament rheostat and two 20-volt dry batteries. Socket accommodates the standard 4-prong tube.

There are binding posts for secondary, tickler, phones and filament battery.

Direct and simple connections may be made to all types of receivers.

Free bulletin R-117 describes this unit. Complete catalogue, 10 cents.

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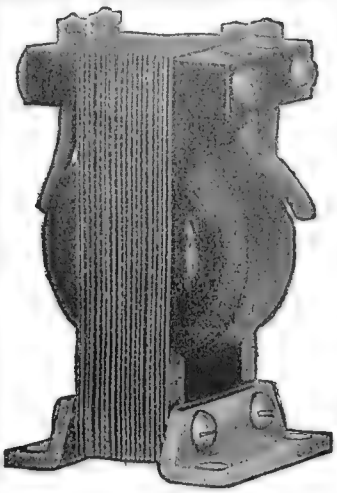

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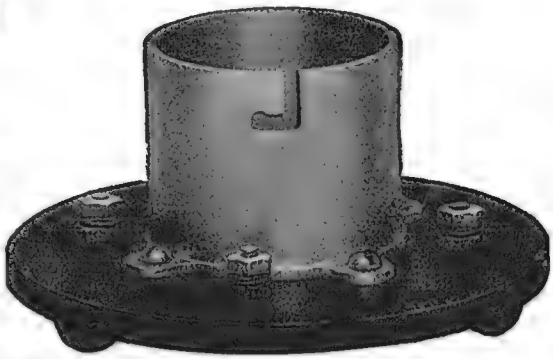

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The base of this socket is bakelite dilecto and will not crack and break like the moulded material of the usual socket.

Contact springs are stamped with identifying letters. Base is provided with three rubber feet and four countersunk holes for panel mounting.

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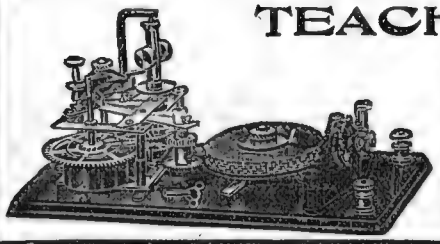

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Tested by Marconi Wireless Telegraph Co. and U. S. Government. Instantly adjustable at a constant pressure.
L. STEWART BARR, Inventor, Vice-President of The Service Radio School
THE BARR MERCURY-CUP DETECTOR Dept. A, The Wyoming, Washington, D. C.

improvised instrument such as a knife blade served to multiply the difficulties. After due patience, however, a leaf was successfully attached and the final assemblage was all that remained.

The top, N, Fig. 2, containing the rod, K, etc., was then shellacked and made fast in place by round-headed brass screws, P and O. The rod, K, was slipt thru the 7/32" hole in the face of the binding post and the charging ball, L, screwed into place.

When in use the thickness of the dielectric of the condenser was varied by sliding the rod, H, up and down the rod, K, while the area of the condensing surface was varied by revolving the rod, H, about K as an axis, the final adjustment being maintained by the set screw, J, in the binding post, I.

Charging was accomplisht by the usual method of induction to avoid the possibilities of a rupture often incurred by the conductive method.

It can readily be seen that when the lower condensing plate is grounded by means of the ground connection, if any ionizing agent such as a radioactive substance be brought near the instrument, the gaseous dielectric of the condenser ionizes and suffers the immediate discharge of the electroscope. Fig. 3 shows the finisht electroscope detecting the presence of a capsule containing a minute quantity of the radioactive substance, Uranium X.

A system of quantitative analysis of radioactive compounds can be devised if the charge, the distance of the substance, the dielectric constant, the distance between and the area of the condensing plates, the temperature, the barometric pressure, and the period of collapse are taken into consideration.

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Fig. 3. The Finished Electroscope Detecting the Presence of a Capsule of Uranium X.

FOREST RADIO-PHONE PROVES VALUE IN TEST.

The forest service wireless telephone works fine in Portland, Ore.

C. M. Allen, telephone engineer of the Forest Service, recently conversed with a friend eight miles distant with perfect clearness.

"In fact," said Mr. Allen, "the sound of the voice came thru the instrument much plainer and clearer than over the wire."

The sets are installed upon the summit of Mount Hood and at the Zigzag ranger station. Mr. Allen therefore tested out the wireless telephone before taking it up the mountain.

Further experiments were made at Government Camp and Camp Blossom before the summit set was packed up the mountain.

The experiment conducted at Portland was between two points of comparatively equal altitude about eight miles apart. A wave length between 400 and 600 meters was used and the sounds were caught by several amateurs who later telephoned to Mr. Allen telling of their experiences listening in.

GENERAL ELECTRIC AND MARCONI COMBINE.

The following statement was issued by Edward J. Nally, vice-president and general manager of the Marconi Wireless Telegraph Company of America, following a meeting of the board of directors of the company:

"The American Marconi Company has the disadvantage of having a substantial percentage of its stock held abroad, and because of patent agreements with the British Marconi Company, of having its operations limited in the United States.

"The research laboratories and engineering force of the General Electric Company have been working for a number of years on radio matters and radio apparatus of great value has been developed which was used by the government during the war for important communications.

"A new corporation has been formed called the *Radio Corporation of America* which has taken over the radio rights of the General Electric Company, and which has proposed to the American Marconi Company to take over its patents and stations and some other of its assets.

"Arrangements will be made such that the new company must permanently remain under American control. It will be amply provided with capital; none of its stock is offered on the market."

World's Big Telescopes

By FLOYD L. DARROW

(*Continued from page* 1139)

removed from disturbances that interfere with astronomical observation, being one and one-half miles from a railroad and seven miles from electric lights.

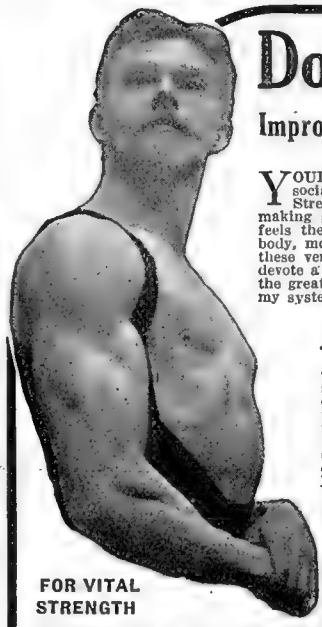
The erection of this observatory was made possible by a gift of Mr. Yerkes to the University of Chicago. The lens was shaped and figured by Alvan G. Clark and was the last work to be done by this famous family, so wonderfully skilled in the technique and artistry of lens grinding. After having made the large Lick lens the Clarks were for the fifth time in their career summoned to construct "a telescope lens more powerful than any in existence." And again they succeeded, surpassing all previous records set by their handicraft with the big 40-inch refractor. Two and one-half years were spent in preparing the lenses and the cost was about $125,000. The unground blocks of glass cost in Paris $20,000.

The lens with its iron ring and cell weighs 1,000 pounds. The crown glass lens is 2½ inches thick in the middle and ¾ inch at the edge. The focal length is 61 feet. Its light gathering capacity is 20 per cent greater than that of the Lick glass and therefore has a greater penetrating power into the infinite depths of space than any other telescope of this type. Only 28 per cent of the light falling on the lens is lost by reflection and absorption. Fully 72 per cent passes thru, but this is larger than with most other lenses. It gives a magnification of 4,000 diameters and has a resolving power sufficient to separate stars about 1/10 of a second of arc apart.

The first observations were made with this giant refractor on the night of May 21, 1897, and the dedication ceremonies took place October 18-22 of the same year.

The family of the Clarks has past away and the world no longer possesses master craftsmen of the highest skill in the difficult art of lens grinding. Therefore the Yerkes refractor will doubtless long remain the largest instrument of its type and

(*Continued on page* 1216)



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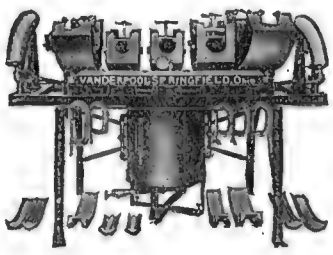

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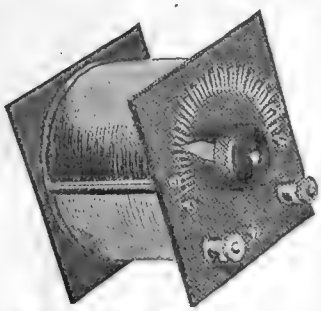
"Tewno" Variable Condenser

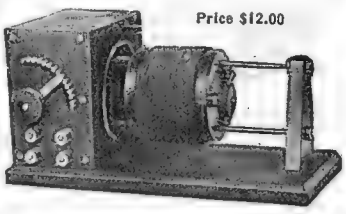


The rotary variable condenser is a necessity for all experimental wireless work and one or two of them are to be found in almost any wireless station. The two most popular types are the 43 plate and 21 plate with capacities of .001 mfd. and .0005 mfd., respectively. The large size has 21 rotary aluminum plates and 22 stationary aluminum plates. The small size has 10 rotary and 11 stationary plates. The ordinary rotary variable condenser is mounted in a cheap round metal case with a cheap composition top and coarse scale. Its plates are 0.15" thick and the shaft is 3/16" in diameter.
The "Tewno" Rotary Variable Condenser has two genuine "Formica" ends, a clear glass case, a ¼" shaft and plates .024" thick of a special grade of aluminum. However, the biggest feature in favor of our condenser is the form of end-piece used. It is square, facing the operator. It is not necessary to look over one's hand to see the scale, as was the case in the old upright type of condenser. The scales on these instruments are calibrated to 2½ degrees.
We recommend our 43 plate condenser for primary and secondary tuning on sets of fair range and for use in oscillating circuits. Our 21 plate condenser is well adapted to short wave tuning for use in small wave meters and a great variety of work calling for a small variable capacity.
Do not be fooled by an instrument that is "just as good." These are to date the best condensers on the amateur market.

No. 53—21 plate—.0005 mfd.....Price, $4.75 **No. 43—43 plate—.001 mfd.....Price, $5.50**

"Tewno" Receiving Transformer (Short Wave)

Directly prior to the war, the amateurs were doing wonderful work with specially made short wave couplers of their own construction and through the use of Armstrong circuits or with straight audion circuits. Up to that time no manufacturer had placed such an instrument on the market.
In our short wave receiving transformer the amateur will find the embodiment of all of his ideals. It is designed for use on amateur aerials of from 150 to 200 M. fundamental wave length and with a small capacity of variable condenser across the secondary will easily tune to 600 M. The windings are of the very efficient type known as bank wound (an expensive process) and are of heavy stranded conductor in silk sleeving. They are wound upon non-shrinkable tubes. Variation is obtained by means of two 12-point switches mounted upon "Formica." Switches and contacts are satin finish, nickel plated, which is in accord with the Government's specifications. All other metal work is polished and nickel plated. Woodwork has a beautiful hand rubbed mahogany finish.



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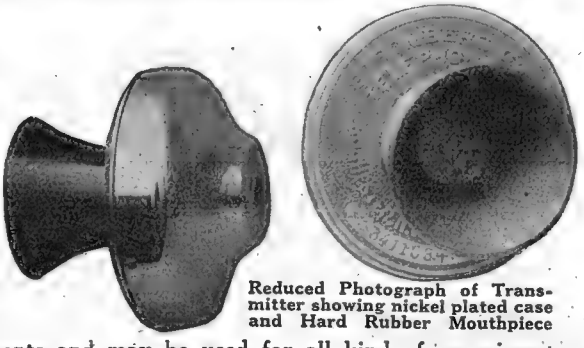

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"Whispering Ether"

By CHARLES S. WOLFE

(*Continued from page* 1131)

He was talking again. "My man," I wriggled when he spoke, "the men for whom you work are imbeciles. I have named my price for Chero, and they don't want to pay it. They believe they can wrest it from me by force or trickery. You are their first emissary, and it is my wish that you be their last. I am going to convince them that it is useless to attempt anything of the kind with me. I am not going to turn you over to the police. I am going to show you something, and then I am going to send you back to your masters to tell them what you have seen. After that," he smiled, "I don't think I shall be troubled by them. Come!"

He stalked into the next room, me at his heels. There wasn't much in that room—just a table covered with apparatus. I have seen a wireless set. It looked something like that, only—well, there was something different about it.

He pointed to it. Oh! I can see him yet, with his flashing eyes, and his big dome. "There," says he, "is the mind machine. And you, a criminal, are the first man to see it except its creator."

I'm getting on my feet again, and not so scared, and so I gazes at it curious. "What is it, Doc?" I asks.

"It reads your thoughts," he says, just as solemn as an owl.

That's right, laugh. I don't blame you. I grinned myself. He saw me grin, and he turned on me like a tiger.

"Dolt," he hollers. "Clod! You doubt. Pig! Your type has retarded the progress of mankind throughout the ages. You sneer—you imbecile!"

Well, just then I'm like the doctors. "A nut!" I thinks, "and loose with that bottle of Chero in his pocket!" And it's up to me to soothe him.

"How does it work?" I asks, to gain time. When you're in a room with a nut that's nursin' a bottle of H. E. your one thought is to go away from there. And this particular nut don't want me to. But I have hopes.

By dumb luck I hits the right chord. "How does it work?" gets results. Right away he seems to forget he's mad. He seems to forget I'm a yegg. He gets kind of dreamy, and he runs a caressin' hand over the shiny brass of the nearest instrument.

"Simple," he says, "very simple. It is based on the electro-magnetic wave and the conducting ether theories." It's over my head, but I listen. "Have you ever considered just what happens when you think intensely? By an effort of what you call the Will, you concentrate on what you are thinking. Emotion, too, plays its part. You are intensely angry, intensely worried, intensely interested. This concentrating acts physically on the brain. There is a call on the heart for more blood. And the heart responds, sending a thicker, faster stream to the affected locality. Now what happens?" He turned to me like my teacher used to do in school when there was a question to be answered.

"Search me," I murmurs.

But he doesn't even see me, I guess. "The increased stream, rushing at an unusual rate, rubs against the walls of the veins and arteries of the head, *producing friction.*"

"I see," I says, politely. But I don't.

"This friction is the physical result of the mental action. Your purely mental process has, by the mediumship of the rushing blood and its attending friction,

been transformed into, or has produced, a physical manifestation."

His voice sank to a whisper. "It is this fact that makes my great invention possible. The friction set up produces faint currents of electricity. It is Nature's own generator. The currents are faint, weak, but they are there. And they vary in intensity in proportion as the rushing blood stream surges and ebbs. Thus they have imprinted on them all the characteristics of the thought that gives rise to them. They vary in the individual. Some minds can generate a current one hundred—yes, one thousand—times greater than others, but all minds generate to some extent.

"And these electrical impulses are thrown out into space in wave trains, exactly as the radio telegraph throws them out. This accounts for the phenomena of mental telepathy. If conditions are just right, the receiving mind in perfect tune with the transmitting mind, and sensitive enough to interpret the received impulses, you have accomplished telepathy. All that remained for me to do was to measure the intensity and characteristics of the generated current, its frequency—and it is high—and——"

He paused and fixt me with that fishy stare. I didn't know just what to say, so I took a Brody. "And what, Doc? Slip it to me quick."

"And the length of the emitted wave," he comes back at me, triumphantly, "It might be one millionth of a meter or it might be one million meters. Or it might be any length between those extremes. Or beyond them, for that matter. I succeeded in making these measurements."

He laughed. Or, rather, he laughed and snarled all at once. I'm telling you straight, fellow, your hair stands on end when Proctor laughs like that.

"I fancy some of your radio experts would gape if they were permitted to see my wave meter. I believe it would cause some excitement in the laboratories of Lodge or Marconi. I—Proctor—I measured these waves which, of course, means that I found a detector for them. Our friend De Forest thinks that he has a monopoly on ultra-sensitive detectors. Proctor's detector is to the audion what a stop watch is to a wheel barrow!

"And the frequency. It is beyond the limits of audibility, as that term is understood. I wound 'phones that will render the received signals audible. And the task was done."

Most of that stuff had gone over, but like a lightning flash the big idea burst thru' my shrapnel-proof cranium. I fairly stuttered as I got his drift. I'll bet my eyes popped as I gaped at that machine. "Good God!" I spluttered, "Do you mean that that thing can hear you think?"

Proctor smiled the nearest to a human smile that I ever saw on his mug. "You have glimmerings of intelligence," he said, in a gratified way; "I mean just that."

And then he went off his handle again. "And I mean," he roared, "that you are to go back to the scum that sent you and tell them that it is useless for them to plot against me, for I can hear their very thoughts as they think them. I can read their miserable souls! That's how I knew you were coming here to-night! That's how I knew that your lethal weapon contained no charge! And," he seized me and shook me until my heels nearly broke my neck, "And that's how I know, you swine, that even now you don't know whether to believe me or not."

He released me and tore the telephone things from off his ears. "Here!" he bellowed, clamping them over my ears, "here! Listen, and be convinced."

He wheeled to the table and whirled knobs and dials. A continuous humming and buzzing sounded in the 'phones.

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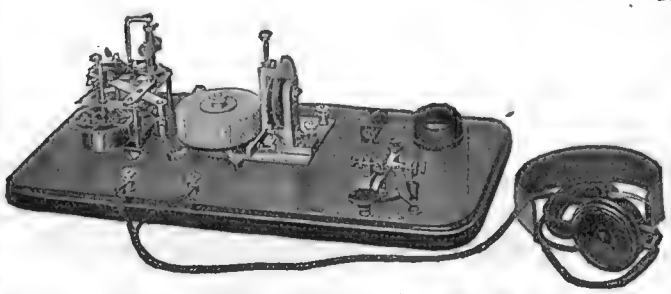

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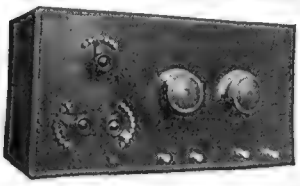

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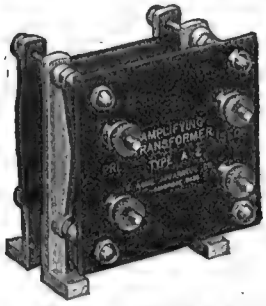

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Type A-2	Core and coil assembled.....	$4.50
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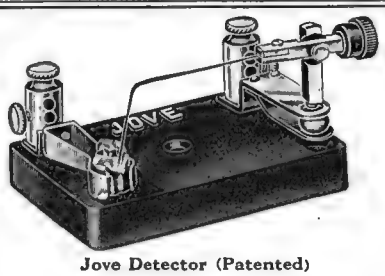

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DORON BROS. ELECTRICAL CO. Hamilton, Ohio

And then it happened. Listen to me close. I know they labeled Proctor "squirrel food" for telling them less than this, but—— This was *July of* 1914. Get that?

Suddenly something like a voice—no, not like a voice, either—like a voice inside my own head, if you can get me, said, masterfully, *with a strong German accent, "Serbia will, because she dare not submit. France must, because she will see my hand behind it. England must as a last desperate effort to save herself. But my armies will grind them like grain in the mill. And then——"*

Proctor tore the 'phones from me. I was like a stuffed doll and I never raised a mitt. He grabbed me, and it was just like being caught in the jaws of a vise. "You have heard," he thundered. "Now go."

The last thing I remember was that he heaved me toward the door. I remember spinning toward it. And that's all.

The next thing I remember is waking up in that hospital ward. It was July of 1914 when Proctor chucked me, and it was late August when I found myself in that hospital.

As near as I can learn I missed the door, hit the wall and a bottle of that Chero stuff got knocked off a shelf. They dug Proctor and I out of the ruins, and we were both pretty well messed up.

Proctor raved about his ruined mind machine, and it got him a pass to the squirrel cage.

If you read the papers at the time you'll remember Proctor wanted me to back him up, but I wouldn't talk. Least said, easiest remedied.

Now you got all I know about it. I spilled it once to Gentleman Joe, a high-browed crook, who soaked up all they pass you at Harvard when he was young. Joe said maybe Proctor fooled me with a camouflaged phonograph.

Maybe he did. I might think so myself if it had happened in *September* instead of *July*, 1914. Get me?

The Amateur Magician

(*Continued from page* 1198)

coil to the transmitter. This will magnify any voice undulations about 400 times with a two-stage amplifier, *i. e.*, an amplifier using two bulbs. This current then passes into the large table coil. The operator in this room can hear everything you say because of the dictagraph device under the table made possible by use of the *Skinderviken* transmitter button, a minute transmitter answering the purpose very nicely. Upon hearing your question and giving sufficient thought to the matter (if any thought is necessary), he formulates an answer. This then is transmitted into the table coil and by *induction* is heard from the loud-talker within the skull."

"It is, I believe, the simplest trick that has ever been used," said Professor Hargrave, "and is original in the present adoption, inasmuch as the voice is amplified, which is contrary to other devices of similar nature. The transformer used in the diagram which I am about to draw is the ordinary audio-frequency iron-core transformer used in radio circuits for a one-stage amplifier; employing only one bulb, this is entirely unnecessary. An ordinary telephone transformer answers the purpose very well. A heavy duty transmitter is used at this end of the line, and a *Skinderviken* microphone button at the other end (the skull end). A good 75 ohm telephone receiver, such as that built by the leading telephone companies, answers for the loud-talker, as a horn is added to it. Carefully checking over of the diagram will show exactly the set-up and arrangement of the apparatus, together with dimensions necessary for duplicating this stunt."

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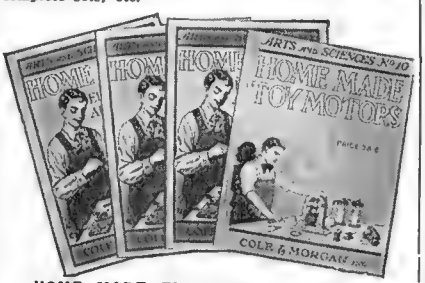
THE OPERATION OF WIRELESS TELEGRAPH APPARATUS shows how to obtain best results and greatest ranges with all kinds of apparatus, how to tune the station to 200 meters, use a wave meter, apply for license, etc.
EXPERIMENTAL WIRELESS CONSTRUCTION gives details, with working drawings for making more elaborate and efficient sending and receiving apparatus, complete sets, etc.



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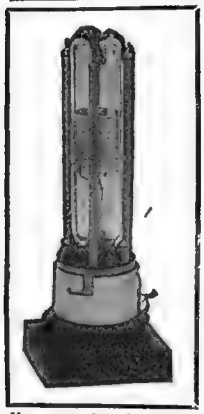

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New Commutatorless A. C. and D. C. Machine

By RICHARD A. ENGLER

(*Continued from page* 1145)

coils; that is, causing them to consume power in driving.

In Fig. 3, a position G, unit one, the lines of force affecting the secondary in any way are nil because the fields of the co-operating coils are short circuited thru the pole tips as shown; and in position G', unit two, there are no lines of force threading thru the secondary in any way because the co-operating fields neutralize each other.

In Fig. 3 one revolution of the rotary coils causes one complete cycle or alternation of magnetism in the pole tips; that is, a certain polarity rises and falls in one pole tip and the reverse polarity also rises and falls in the same pole tip; all in one revolution of the rotary coils.

Noting positions H-H', we see in a given pole end one polarity, while in positions J-J', one-half revolution beyond, we see in the same pole end the reverse polarity. It will also be observed that one polarity uses one pair of the four split pole tips of each unit which are diagonally opposite each other, while the reverse polarity uses the other split pair of diagonally opposite pole tips.

A falling N pole and rising S pole both induce E.M.F.'s of the same direction in the secondaries, while a falling S pole and rising N pole induce the reverse E.M.F.'s. These falling and rising periods are notated in this Fig. 3 and have reference to the upper pole ends. The arrow heads on the secondaries indicate the direction of the E.M.F.'s induced at each rise, fall and reversal.

In Fig. 3 the secondary may surround the primary or co-operating rotary field coils and be wound at right angles to the stationary coil of the primary, then the reactionary fluxes of primary and secondary act mutually on one another more perfectly due to their close proximity and hence increase the efficiency of the transformer.

The secondary may also be wound over the rotary coil or over the stationary coil or over both. Then the induction will be due to rise and fall of the same polarity and not from an alternating polarity.

The small auxiliary secondary shown in the photograph on the rear unit functions like the main secondaries.

The polarity produced in one unit by one stationary co-operating coil in Fig. 3 and the model is opposite to that produced by the other stationary coil of the other unit. This is not necessary, but it allows of having the same polarity in the upper pole ends of both units, and this makes possible *one* magnetic circuit for *both pairs* of co-opertaing coils.

In the positions H-H', Fig. 3, the inert half of each pole tip does not interfere with the operation of the homopolar rotating field, because as can be seen at these points covered by these half pole tips, the S pole of the stationary coil and N pole of the rotary coil and vice versa face each other and produce, therefore, a neutral condition. This same condition is met with in the coils of the Tesla rotary magnetic field.

At H the two coils will oppose any further motion tending to close them; at H' this opposition will be neutralized by the lines of force passing into the short circuit stage by further motion and thereby reaching around the rotary coil and drawing it open, all in accordance with the principle explained under Fig. 2. The same

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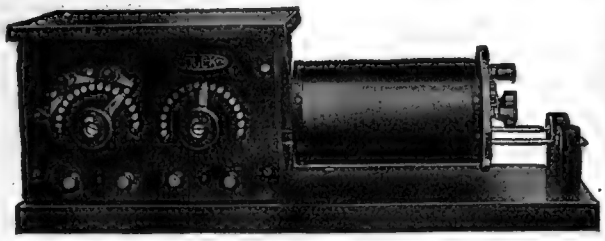
DUCK'S

New Big-264 Page No. 13 Wireless and Electrical Catalog

Will be mailed for 12c in stamps or coin which may be deducted on first order of $1.00. Catalog not sent otherwise. We regard this catalog as our greatest effort. It embraces everything in wireless worth while. 172 pages with no waste space devoted exclusively to wireless instruments. Your amateur friend will tell you that there never has been any wireless catalog to take the place of catalog of this company and above all that you can absolutely depend on our goods. There is no need for any other catalog when you have this big catalog.



A big improvement over our former model. Primary divided into four sections, with three dead end switches, greatly improving selectivity.

Secondary divided into three sections, with two dead end switches, eliminating harmonics. The change in the construction of the guide rod support makes it possible to obtain a looser coupling. It is a wonderful improvement over our old model both in performance and appearance. Only $23.50.

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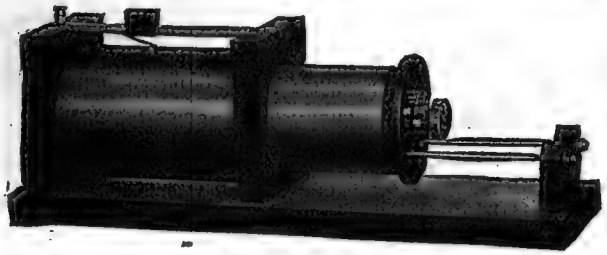

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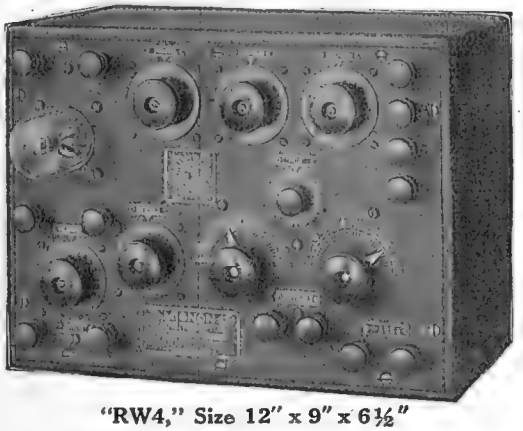

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SUPERIOR MIGNON SYSTEM APPARATUS

conditions obtain in positions J-J', but in the reverse order with respect to the units.

If a pair of units with coils in the positions such as G-G', Fig. 3, are combined with a pair with coils in the positions such as H-H' and so that all rotary coils are mounted upon the same shaft, then polyphase E.M.F.'s can be drawn from the secondaries, because when the G-G' poles are at zero, those at H-H' are at a maximum, consequently these E.M.F.'s cause currents to flow in the H-H' secondaries which are a quarter period behind those in G-G'.

If the stationary secondaries are replaced by properly connected rotary ones, we arrive at the "Induction Motor," one with staggered rotor coils instead of staggered stator poles in this case with such a polyphase arrangement of units. We then have in reality a *commutatorless D.C. motor*, a much desired and long looked for machine as well as a very simple one.

True Tesla rotary magnetic fields can be produced by a proper combination of the polyphase poles of the several homopolar rotary field magnets.

Tesla (and Ferraris) past several A.C. out of phase with each other thru several pairs of stationary coils with phase displacements and obtained from the combination a rotating magnetic field of constant value just as if the same had been produced by a single D.C.

Here we pass a single D. C. thru several pairs of coils, of which one of each pair is stationary, while the other of the pair passes thru phase displacements from zero to maximum and back to zero, thereby obtaining from the combination stationary alternating magnetic fields, just as if the same were produced by several A.C.'s of different phase. Tesla's motor based on the above rotary field is self-starting, whereas my motor based on this homopolar rotary field is not, but is *easily* made so.

Thus the conditions in and results of one method are just the reverse of those in the other. Being just the exact reverse of the Tesla rotary field method or system is alone proof positive that the principle disclosed herein is correct in theory and practice.

We may use these homopolar rotary magnetic fields to drag around iron masses which is then another form of motor.

If the stationary co-operating coils in such an apparatus as Fig. 3 are placed so that they are at right angles to the position now shown in Fig. 3, then instead of alternating magnetic fields we obtain simple rising and falling magnetic fields in each of the magnetic circuits.

With a pair of such units we can also obtain magnetic fields of constant values, because as the magnetism of one unit falls the same polarity of magnetism rises in the other unit and the rise and fall are equal in degree. Hence, the combination of the two are equal to a constant magnetic field just as if it had been produced by an ordinary D.C. electromagnet.

An iron core is provided in Fig. 2 upon which the rotary coil is wound. This core may have a segment cut away on each side as shown by the dotted lines in unit E. This form of rotary coil and core is useful when this homopolar rotary field electromagnet is used as the armature of another type of commutatorless D.C. or single phase A.C. motor. This form of motor has also been experimentally proven.

If we have three sets of co-operating coils with the rotary coils all keyed upon the same shaft and spaced 120° apart, then we obtain a three phase system and the actions and reactions between the fields of the rotary and stationary coils of the several units neutralize each other so that no power is consumed in driving the rotary coils.

The homopolar rotary field coils may be variously formed and disposed; and the

magnetic fields produced by them used and combined in a great variety of ways, and the magnetic circuits may vary in form in any way to suit any particular use of the homopolar rotating magnetic field; and both D.C. or A.C. may be used in the co-operating coils; and when D.C. is used in the co-operating coils, its strength may differ in the stationary coil from that in the rotary, thereby making possible magnetic fields of various wave forms. By varying the widths of the co-operating coils we may vary the wave form of the magnetic field also.

Besides single phase, polyphase and direct current motors and transformers, this electromagnet lends itself to various new types of A.C. rectifiers; but all the above it is best to treat of in separate papers.

There is an equivalent system which may be possible, in which the coils and their magnetic lines aid and oppose each other at alternate successive periods, but in which the coils are not caused to be differential and non-differential by being wound over each other, but it is evident that such a system must be far inferior (if at all operative or practical) to the system shown and described herein where both magnetic fields are enclosed by both co-operating coils within the same space.

Since only one coil of the pair revolves, only one-half of the windings of the electromagnet rotate and these windings are in the form of simple coils thru which *D.C.* is flowing, hence centrifugal force and high voltage are no bar to rotation; and direct E.M.F. produces less strain on the insulation than an alternating E.M.F.; and all coils being in series reduces the voltage at the terminals of the rotary coils so that excessive voltage can be used in the various applications of the electromagnet.

Either the stationary or rotary coils, however, must produce polarities of opposite direction in a pair of units in any case. Fig. 2 has the rotary coils with polarities in a different direction in each unit.

Any number of sets of units such as Fig. 3 may be used and thus obtain any number of phases by giving each set a proper phase displacement.

Tesla uses a continuous magnetic circuit. I use a discontinuous magnetic circuit. The lines of force in the magnetic circuit surrounded by the coils in the Tesla system reverse in direction, whereas the lines of force in the magnetic circuit surrounded by the coils in my system do not reverse in direction.

My motor starts with full load just as Tesla's does, because the starter is applied on the co-operating coil shaft and not on the main shaft and in this respect it differs from all other non-self-starting motors, whether A.C. or D.C., which latter must all have the starter on the main shaft.

Three such sets of units as Fig. 3 may also be employed to get a three phase system, each set with the rotary coils at 120° displacement from the others.

RELEASE RADIOS.

Naval operation or control of all private radio stations, assumed during the war emergency, was relinquished at midnight, February 29, under an executive order by Secretary Daniels.

At the office of Naval Communications it was explained that all stations taken over by the Government at the outbreak of the war would be returned to their owners and that all new stations built during the war by private concerns and which could not be operated because of the wartime restrictions, could be operated after February 29.

Six high-powered stations controlled by the Radio Corporation of America were taken over at the outbreak of the war. They are at Marion, Mass.; New Brunswick and Tuckerton, N. J.; Bolinas and Marshall, Cal., and Kahuku, Hawaiian Islands.

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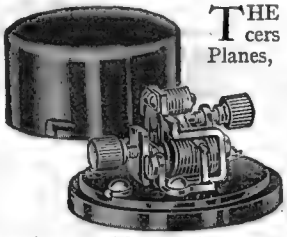

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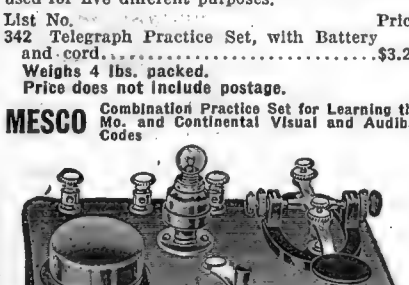

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Invisible Optic Telegraphy by Infra-Red Rays

By HENRY de GALLAIX

(*Continued from page* 1127)

of the parabolic mirror; it then runs over a second roller O¹ which tightens the ribbon and finally comes back to the box. Like a transmission tape, this band of paper always follows the same circuitous way. The speed of the movement is regulated according to the speed of emission of the Morse signals. If the transmission of the messages is speedy, it is convenient to give a greater speed to the ribbon and vice versa. The whole of the receiving mechanism, clockwork ribbon and its bearing can, by means of a micrometric dead-end screw and sliders P and R, move forwards and backwards so as to make it possible to always obtain the absolutely correct focus. At the top of the transmitter is an ordinary lens T, permitting a clear inspection of the telegram written on the endless paper ribbon.

Now let us see the physical phenomena which takes place in the receptor when the infra-red rays are received. These rays having gone thru the colorless glass fall on the parabolic mirror, which reflects them to a spot called the focal point. All rays are concentrated at the focus before dispersing again.

Therefore at this focal point the paper tape is arranged to pass, and which receives all the infra-red rays concentrated in one spot. This ribbon, the composition of which is quite special, and, in which enters a good deal of zinc sulfate in allotropic condition, has the curious peculiarity of turning black instantaneously, when subjected to infra-red rays. The ribbon forming a closed circuit, it seems unavoidable that, after a full turn of the ribbon, fresh signals should be inscribed over the old ones. But a second and wonderful peculiarity of that paper is then used. The spot on the ribbon which has already recorded a signal, before coming for the second time to the focus of the mirror, goes thru a small closed chamber where it bathes in *blue light*, which has the effect of blotting out the black traces left on the paper by the infra-red rays.

From a military point of view, this has great significance. An apparatus of this type falling into the enemy's hands, even intact, will not reveal anything about the messages previously received, since soon after their emission and after they have been read, they are utterly effaced and could not be reproduced by any means. [*The signals would efface themselves in a short time anyway without the blue light bath, even tho a little more slowly, as Dr. Peter Cooper Hewitt has pointed out.—Ed.*]

Now that the description of the transmitting and receiving apparatus is complete, we may say a few words about their use and efficiency. To make telegraphic communication possible, the transmitter and receiver must face each other, so that the central longitudinal axes of the transmitter and receiver line up. Therefore careful aiming is necessary, and it is the first operation to be done when transmitter and receiver are set up first. For daily transmission transmitter and receiver are provided with a tubular sighting device without lens, but when the distance between the two apparatuses increases to one, two or three miles, telescopic sight is then required. If the sighting is done at night, the same devices are used, but the position of each apparatus is indicated by a quick flash of light produced by an ordinary electric flashlight. The receiver playing but a passive part in the invisible optic telegraphy, the

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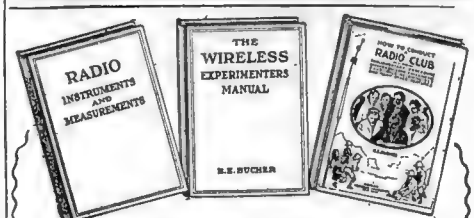

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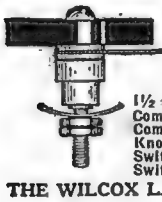

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distance at which messages sent by infra-red rays can be received depends almost entirely on the power of the transmitter. Having had, at the battle front, the opportunity of testing the apparatus which I have just described, the numerous practical tests to which they were submitted gave the following results:

A transmission of one-half mile for a transmitting apparatus of a diameter of one foot; and a transmission of one, two and three miles for transmitters of two, three and five feet of diameter. These transmitters were electric searchlights on which a red manganese glass had been adapted. To be impartial, after enumerating the many advantages of the invisible optic telegraphy, I might as well confess its principal defect, for which no remedy has been found so far, but which it is hoped will soon be found. That defect is the great loss of energy incurred by first producing a source of white light and then in using only the infra-red rays incident to it. It is the greatest portion, say nearly 99/100ths of the luminous energy, which remains unproductive and thus the efficiency of invisible optic telegraphy compared to ordinary telegraphy is greatly reduced. But the advantage of its invisibility compensates in a large measure for this loss of energy. On the other hand, the solution which seems the simplest, i. e., to create directly a source of pure infra-red rays and emit them without the help of a manganese glass, which would no longer be of any use, has been studied for a long time.

INVISIBLE LIGHT IN WARFARE.

When a source of light is put at the principal focus of a converging lens the emergent beam consists of parallel rays and consequently does not change in cross-section as it proceeds. Often the narrowness of such a beam prevents its being observed. Greater accuracy was obtained by using a filter which permitted only the extreme red rays to issue. These would be invisible to an observer unless he protected his eyes from daylight by a similar screen, says R. W. Wood in *Proceedings of the Physical Society, London.* Through such a screen *only the red light could penetrate* and the eyes of the observer would be in a sensitive state owing to the exclusion of ordinary light. By such an arrangement secret signals can be transmitted. A variation of method was the use of a screen transmitting only ultra-violet light, which was received on a fluorescent screen. The range of signaling in both cases was about six miles.

The following arrangement proved of great value in maintaining communication between ships of the same convoy at night. In this case the light was sent out not as a parallel beam, but as a beam diverging in all directions. A Cooper-Hewitt mercury arc was the light source. It was surrounded by a glass chimney thru which only ultra-violet light emerged. This caused parts of the eye and natural teeth to fluoresce, while false teeth were black. The receiving apparatus is a barium-platino-cyanide screen placed in the principal focus of a converging lens. The range was about four miles.

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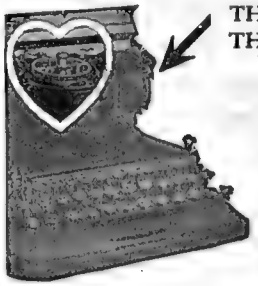

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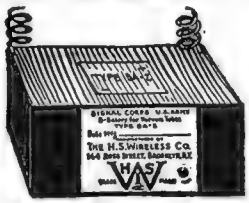

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By FLOYD L. DARROW

(*Continued from page* 1207)

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This article will not be complete without some brief account of the casting and grinding of a large lens. It is a task of unparalleled difficulty and requires the highest skill and the utmost patience. The big crucible in which the glass is melted consists of the purest clays and is made by specially trained craftsmen. Before receiving the "batch" materials it is heated very gradually for a week to a high temperature. Every step of the process is under perfect control and the stirring and melting proceed for days. When the glass is ready, skilled workmen lift the crucible from the furnace and pour its molten contents of dazzling brilliancy into an iron mold lined with sand. The mold is covered with an iron plate and lifted into an annealing furnace, *where it remains for a month very gradually cooling* from its high temperature down to ordinary temperature. But, if this annealing is not properly done, the glass will possess strains and inequalities that render it unfit for optical purposes.

Next comes the preliminary, rough grinding which alone requires several weeks. At frequent intervals the glass is examined for strains, veins and bubbles—flaws which may destroy its optical qualities. In this inspection work the *camera,* the *microscope* and an instrument called the *polariscope* are employed. The glass for the Lick objective was poured twenty times, with a month consumed for annealing after each pouring, before a satisfactory result was obtained.

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(*Continued from page* 1165)

tell how we are sending our text-books back to be altered to fit the latest model theory—one that seems to have come to stay—only time can tell that."

"You've told us all about the stuff now," Wyman Stewart spoke up, cramming his hands into a leather coat and looking intently at a picture of a girl in Los Angeles. "Now what *is* it—anything like babism or reverse English?"

"It—the theory of relativity is something to the effect that a light ray is deflected like radioactive emanations by certain forces. Take radium for instance. We find there are the emanations, the researchers nicknamed Alpha, Beta, Gamma. A, B, C, in English. One of these emanations seems to be nothing more than an ethereal disturbance, the other two are affected by the magnet; still the other is affected, if we could run across some affector—perhaps.

"In electricity we find that there is a strict relation between what we term electricity and magnetism, one induces a corresponding flow in the other. If we only could fathom it out we would find that that relation extends—later I look for the fact to be unearthed bringing to light the knowledge of the relations, and further knowledge of the extent of the relations—we would find that the light, current flow, magnetic flux, sound, etc., which are resultants of the working of a force we define as vibration, are able to be controlled by the proper manipulation of that force. What I mean is that we could shine a light around a corner without the use of a mirror, as we distort visions with lens and change sound vibrations with the audion amplifier. And that is not all. We would know more of mind and metaphysics as a result of our researches.

"The deflecting of the light beam by the sun proved that light rays were affected in much the same manner—perhaps—as the magnetic and electrical fields deflect the Alpha and Beta rays——"

"And I heard something about the old chronometer being given the cold hand as far as universal time was concerned," Punk interrupted.

"Yes, for the very simple reason that TIME exists ONLY in man's mind. Nature knows no such thing as TIME. Anyone can see that time would be different at different places in the universe. We gage our Ingersolls by the revolution of the earth on its axis and its annual trip around Old Sol. The Martians set their Walthams by another scale. As the Centigrade and Fahrenheit scales don't change the temperature, neither do our conceptions of time alter the seasons. Because the inhabitants (were there any) on the moon and those of Mercury couldn't agree about a certain stellar happening—one saying it was so many days ago, the other saying it was so many months or years (if they calculated so)—wouldn't make either one necessarily incorrect. There still exists the mathematical relations, and by clever computing we could devise a schedule card for interplanetary communication that would keep the peace and harmony of the universe uninterrupted."

"An' they couldn't be much worse than our railroad time-tables at that," added Bender.

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A man's happiness largely depends upon his Vital Powers; his success in social, domestic and business life all centres around this. If he is not virile, he is not magnetic, forceful or attractive; neither is he sought after—his very strength is the axis upon which all else relating to him revolves. Men become weak through overwork, worry, sexual abuse and bad habits, and gradually lose their strength and manhood. When they reach the stage when they find their strength on the wane, it is the forerunner of failure and domestic happiness is then soon upset. Young men become incapable of marriage, listless and purposeless; their brain power decreases as their manhood fails.

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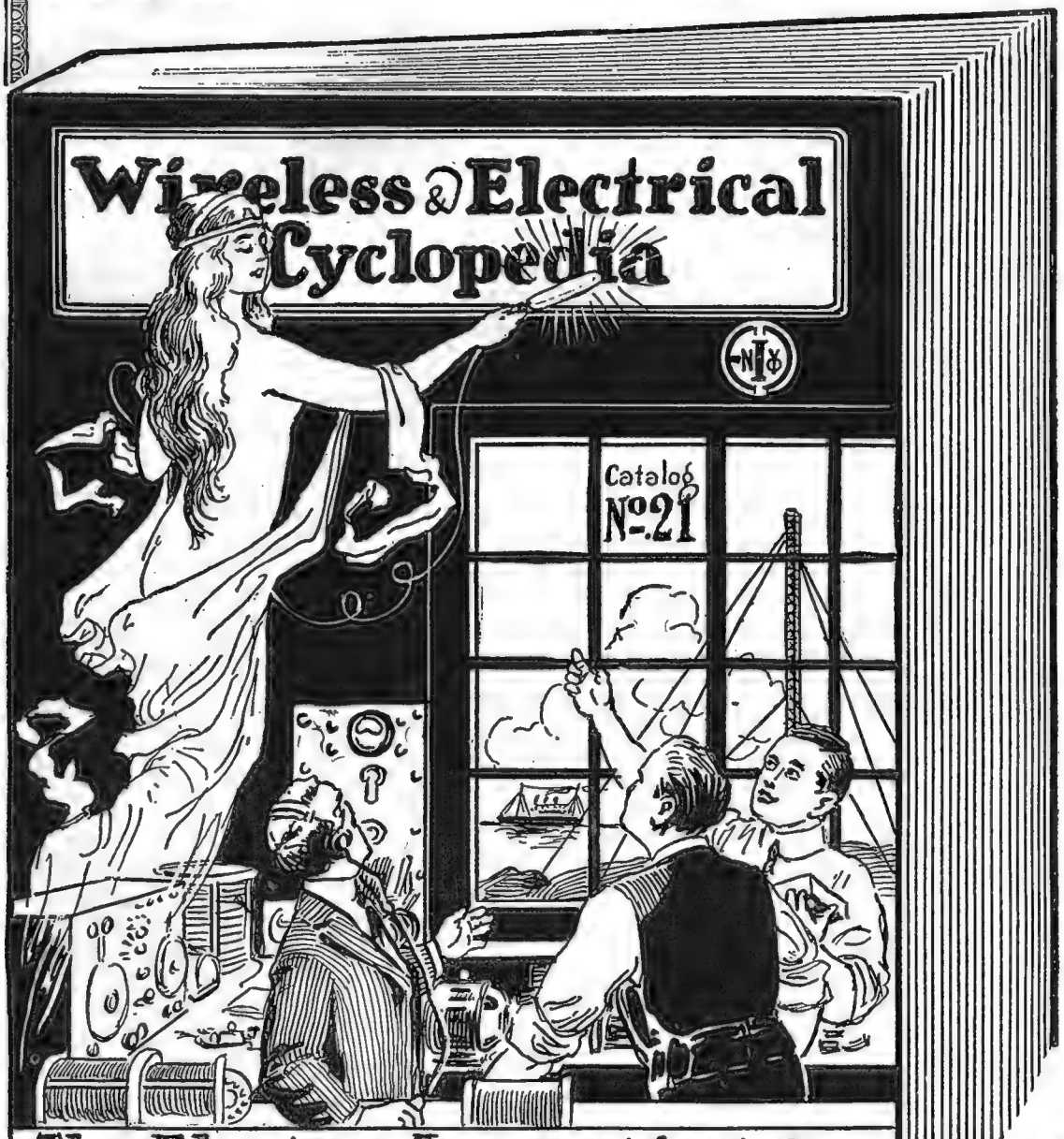

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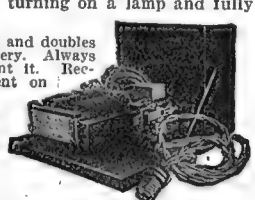

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A Land and Water Speed Demon

By EMERSON EASTERLING

(*Continued from page* 1129)

on the lashing deep—that don't mean the ocean; it's the *briny deep.* Forgot to mention that machine is steered in water by means of disc on front wheel, which cannot be seen in picture.

What do you think of the idea of escaping from the Federal authorities—you know that you just can't cut out your wireless experimenting, even if the Government says *NO* to you, er, ah, *us*—after they have discovered that you have an active set in your garret in one of the Frymobiles?

Of course, all "Radio-Bugs" will not be satisfied with such an invention unless it has a set of ether machinery aboard. Wouldn't it look great to see yourself whizzing along with a dot-and-dash hook stuck up on *her?* I'll bet you would have to drive down by Maggie's house, wouldn't you?

But if you should, don't start up your motor when friend Maggie—or is it Jane—is near the rear, for fear that your dear would be swept clear of the sidewalk—the old boat has some breath (no, not any per cent)..

Also, kids, if you should change your mind as to destination you could get around pointing in the other direction in as quick a time as any other vehicle. The—aeromobile, if you care to—can turn in its own length.

But as yet our friend Byron has no reverse. But it is in its experimental stage now.

But the machine is equipt with brakes—for land use—so that when friend driver spots a "speed cop" in the distance he can slow down before he gets the polite request to appear before the judge the next day.

If you have traveled in an airplane, a Ford and a submarine you should complete your variety by a ride in the—land-flivver. It takes the roads like a ten thousand dollar and twenty cent car.

Silvering Mirrors

By D. McCLANAHAN

(*Continued from page* 1147)

trated or 26% ammonia—when the silver has dissolved add ½ pint of distilled water and let it stand 24 hours—filter and it is then ready for use.

Solution No. 2—Dissolve 8 ounces of tartaric acid in one quart of distilled water, let it stand for 24 hours—the older this solution gets the better. Reduce this to 10% by using an acid hydrometer—if it should be stronger than 10% add distilled water until it becomes so. Filter before using.

To silver, take 4 ounces of Solution No. 1, put it into 1 quart of distilled water. Take 4 ounces of Solution No. 2, put it into 1 quart of distilled water—next mix Solutions No. 1 and No. 2 by pouring from one pitcher to another—then flow the solution on the glass, allowing it to remain for one hour.

Metallic Mirror Process.

Make a liquid preparation by melting into a porcelain vessel 1 dram of lead, 1 dram of tin, 1 dram of C. P. Bismuth. When these are melted together add 10 drams of mercury before the mass has cooled. The mercury will cool it sufficiently for use. Lay the glass flat with the clean side up and pour the metallic liquid over it, completely covering. Raise the glass almost perpendicular, letting the amalgam drain off. When the coating has become hard and dry, coat with drop black ground in Japan, and then thin with turpentine.

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GEORGE HEINEMANN
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January 15, 1920

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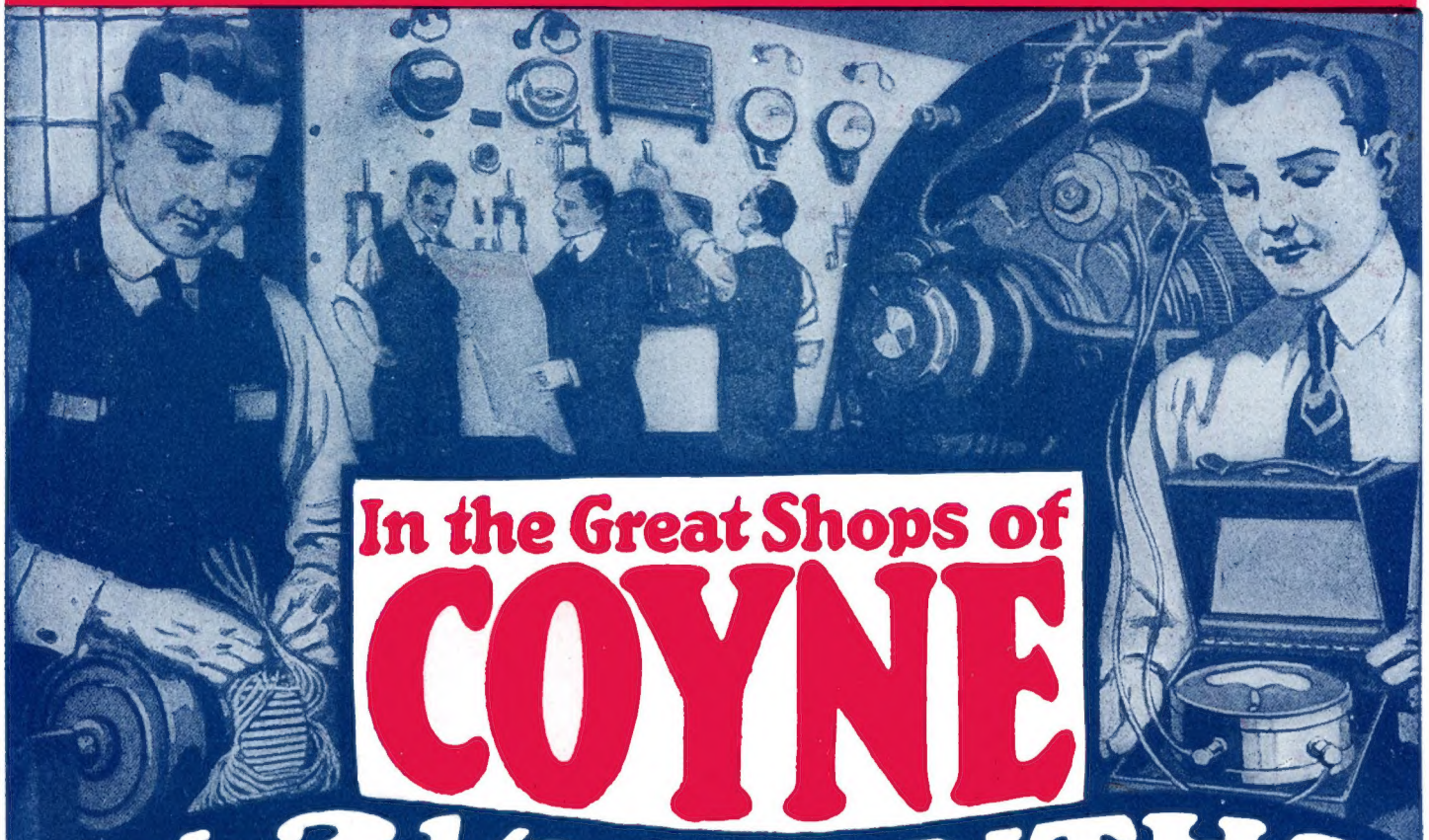

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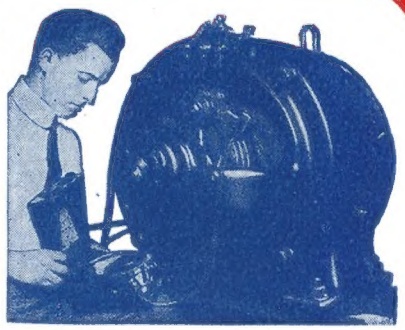

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